PE07-057

FORD

2-4-2008

APPENDIX K

DFMEA - Lower Steering System

Ford Motor Company

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
- DESIGN FMEA -

DRAFT

_X_ System: 1100 STEERING SYSTEM
___ Subsystem:
___ Component:

Design Responsibility: 2005 P131 Steering System FMEA

FMEA Number: 0000 - imported from lwrstg.f2f

Prepared by: JBARRY / JDAVIS78 / DWILLMER

Vehicle Program: 2005 P131 / 2005

Key Date:

FMEA Date (Orig.) 6-Dec-1997 (Rev.) 9-Jun-2004

Core Team: Please refer to the last page of the document for a detailed list

Item/Function	*Potential Failure Mode*	*Potential Effect(s) of Failure*	*Sev*	*Class*	*Potential Cause/ Mechanism of Failure*	*Occ*	*Current Controls Prevention*	*Current Controls Detection*	*Det*	*RPN*	*Recommended Action*	*Responsibility and Target Completion Date*	*Action Results Actions Taken*	*Sev*	*Occ*	*Det*	*RPN*
[1] ********** THIS DOCUMENT HAS BEEN REVIEWED AND IS IN COMPLIANCE WITH FORD MOTOR COMPANY FMEA STANDARDS **********	[1.1]				[1.1.1]						[1.1.1.1]						
[2] Assumptions: - 10 years / 150,000 miles - Meet requirements of SDS and WCR - XR50 steering gear - Modified Haltenberger linkage with greasable fittings - CIII pump - Hydraulic distribution including hoses, cooler, & reservoir	[2.1]				[2.1.1]						[2.1.1.1]						
[3] Provide vehicle directional control to the driver. (Subjective Evaluation)	[3.1] Complete loss of vehicle Steering control.	No Vehicle directional Control.	10	YC	[3.1.1] Steering column system defects	2		CAE Column Structural Fatigue Bi-Directional Durability R318/R360 Vehicle Durability See Column FMEA See Column DVP	3	60	[3.1.1.1] None at this time						
				YC	[3.1.2] Gear system defects	2		CAE VE5C3C-3504-AA Section III.J-Block Cycle Fatigue (Visteon Gear DVP) VE5C3C-3504-AA Section III.H-Gear Impact (Visteon Gear DVP) R318/R360 Vehicle Durability See Gear FMEA	3	60	[3.1.2.1] Increase sector shaft diameter. Review Gear FMEA	J.Barry J.Barry 3-Jan-2003 OVERDUE	Sector shaft diameter increased to 1 5/8". Testing confirms Steering gear FMEA reviewed and accepted by Supplier & Ford	10	1	2	20
				YC	[3.1.3] Corrosion	3		Supplier recommendation R311 Vehicle Corrosion Salt spray on gear & linkage See Column, I-shaft, Gear, & Linkage FMEAs Steering SDS (SG-	3	90	[3.1.3.1] Improve corrosion protection on linkage studs	J.Barry	Geomet added to linkage studs.	10	2	2	40

			0054: Corrosion Resistance)											
YC	[3.1.4] Package interference	2	WCR clearance Design clearance checklist VSA studies Design Aid buck Fresh Eyes Reviews Compatibility Reviews R318/R360 Vehicle Durability	2	40	[3.1.4.1] Perform clearance/interference check after each design change.	J.Barry/J.Davis	All design changes evaluated in Digital Buck with designer.	10	2	2	40
YC	[3.1.5] Foreign objects lodge in steering system or to adjacent components	2	R318/R360 Vehicle Durability Vehicle Corrosion Test Clearance check Design aid buck Steering SDS (SG-0188: System Damage/Road & Splash Protection)	5	100	[3.1.5.1] Protect I-shaft to gear connection.	T Blazer	Plastic collar on I-shaft to gear connection.	10	2	2	40
YC	[3.1.6] Steering Lock-up during Driving.	2	Joint Analysis Torque / Angle Test Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS (SG-0065: Linkage Toggling)	3	60	[3.1.6.1] Review ADAMS data.	J.Barry	ADAMS geometry analysis confirms no lock up condition.	10	1	2	20
YC	[3.1.7] Failure of Adjustment Travel Limiters.	3	Component DVP&R Component FMEA - Ref. Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Fatigue Test Ultimate Strength Test Efforts Test	3	90	[3.1.7.1] ********** Recall # 99B08 **********						
YC	[3.1.8] Improper joint connections at: Column to Upper I-shaft; Upr I-shaft to Lwr I-shaft; Lwr I-shaft to Gear; Gear to Frame; Tie Rod to Knuckle; Strg Wheel to Column	3	CAE VE5C3C-3504-AA Section III.J-Block Cycle Fatigue (Visteon Gear DVP) VE5C3C-3504-AA Section III.H-Gear Impact (Visteon Gear DVP) Fastener torque-to-failure Fastener Torque/Angle Test R318/R360 Vehicle Durability Road load vehicle Inverted Delta items specified in WERS	3	90	[3.1.8.1] Increase steering gear to frame bolt size. ********** Recall # 00S19 & 89S75 **********	J.Barry	Increased steering gear bolt size to 14mm. Gear to frame test conducted.	10	2	2	40
YC	[3.1.9] Gear / Linkage system not adequately designed to handle wear, impact & / or fatigue.	2	Fatigue Test Max. Input Torque Brinell Test Impact Test Gear Attachment Testing Efforts Test See Linkage DVP	2	40	[3.1.9.1] Review linkage DVP. ********** Recall # 99S07 **********	J.Barry	Linkage passed block cycle fatigue test at road loads.				
YC	[3.1.10] Customer mis-use - overloading vehicle - crash - duty cycle	2	R318/R360 Vehicle Durability	2	40	[3.1.10.1] None at this time.						

[3.2] Partial loss of steering control.	Degraded vehicle directional control. Customer discomfort.	8		[3.2.1] Gear / Linkage system not adequately designed to handle wear, impact & / or fatigue.	2		Fatigue Test Max. Input Torque Brinell Test Impact Test Gear Attachment Testing Efforts Test	2	32	[3.2.1.1] Review linkage DVP. ********** Recall # 95S08, 00S48,96B81, 95S17	J.Barry		Linkage passed block cycle fatigue test at road loads.					
				[3.2.2] Suspension ball joint failure.	2		Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Component DVP&R Component FMEA - Ref.	2	32	[3.2.2.1] ********** Recall # 98S37 **********								
				[3.2.3] Suspension / Wheel Failure	2		Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Component DVP&R Component FMEA - Ref.	2	32	[3.2.3.1] None at this time								
[3.3] Excessive lost motion (looseness) when transmitting steering input (Torque) to the wheels.	Degraded vehicle directional control.	8		[3.3.1] Joint Looseness: Steering Wheel to Column; Column to I-Shaft; U-joint; Flex joint; Steering Shaft	3		Joint Analysis Torque / Angle Test Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS - SG-0011 (Steering Integrity-Truck)	2	48	[3.3.1.1]			Torque angle testing conducted.					
				[3.3.2] Joint - Fastener (eg: Bolt) looseness.	3		Fastener torque-to-failure Fastener Torque/Angle Test R318/R360 Vehicle Durability Road load vehicle Inverted Delta items specified in WERS Vehicle Development Testing Steering SDS	2	48	[3.3.2.1] ********** Recall # 00S33 **********			Torque angle testing conducted.					
				[3.3.3] Failure of Adjustment Travel Limiters.	3		Component DVP&R Component FMEA - Ref. Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Fatigue Test Ultimate Strength Test Efforts Test	3	72	[3.3.3.1] None at this time								
[3.4] Pulls / drifts / pointy steering.	Customer dissatisfaction. Potential mis-diagnosis of repair requirements. Degraded system function.	6	**YS**	[3.4.1] Excessive Gear / linkage system friction & / or Play.	4		Lab Functional Testing Component DVP&R Vehicle Development Testing Steering SDS (SG-0035: Accelerated Durability - Linkage Friction; SG-5016: Steering System Friction Downstream)	3	72	[3.4.1.1] Improve tie rod end robustness.	J.Barry		Incorporated lube-for-life tie rod end design: - Neoprene boot seals - LT2/78 grease - Geomet coated studs Eliminated pin joints.	6	2	3	36	
				[3.4.2] Suspension / Alignment / Tire defect.	3		Vehicle Development Testing NVH Vehicle	2	36	[3.4.2.1] None at this time								

									Development Testing R318/R360 Vehicle Durability CAE Analysis Road Load testing Isolator Tuning Nibble Sensitivity Tuning Steering SDS (SG-5001: Steering Recession/Pull; SG-5085: Alignment Stability - Cutomer Usage; SG-5069: Wheel Alignment vs. Wheel Travel)									
				YS	[3.4.3] Mis-Alignment of Tie Rod End during alignment procedure. Socket located off-center of articulation window.	7				8	336	[3.4.3.1] Add use of tool/fixture in alignment pit to control orientation of tie rod end.	Assembly 2-Jul-2004 OPEN	Tool implemented and interlocked to alignment pit acceptance criteria.	6	2	2	24
[4] Convert angular displacement of the steering wheel (Driver"s Steering input) to linear displacement and output to knuckle for a change in direction of the Vehicle (Steering Ratio)	[4.1] Does not convert angular displacement to linear displacement.	No vehicle directional control.	10	YC	[4.1.1] Steering column system defects	2			CAE Column Structural Fatigue Bi-Directional Durability R318/R360 Vehicle Durability See Column FMEA See Column DVP	3	60	[4.1.1.1] None at this time						
				YC	[4.1.2] Gear system defects	2			CAE VE5C3C-3504-AA Section III.J-Block Cycle Fatigue (Visteon Gear DVP) VE5C3C-3504-AA Section III.H-Gear Impact (Visteon Gear DVP) R318/R360 Vehicle Durability See Gear FMEA	2	40	[4.1.2.1] Increase sector shaft diameter. Review Gear FMEA	J.Barry J.Barry 3-Jan-2003 OVERDUE	Sector shaft diameter increased to 1 5/8". Testing confirms Steering gear FMEA reviewed and accepted by Supplier & Ford	10	1	2	20
				YC	[4.1.3] Corrosion	3			Supplier recommendation R311 Vehicle Corrosion Salt spray on gear system See Column, I-shaft, & Gear FMEAs	3	90	[4.1.3.1] Improve corrosion protection on linkage studs	J.Barry	Geomet added to linkage studs.	10	2	2	40
				YC	[4.1.4] Package interference	2			WCR clearance Design clearance checklist VSA studies Design Aid buck Fresh Eyes Reviews Compatibility Reviews R318/R360 Vehicle Durability	2	40	[4.1.4.1] Perform clearance/interference check after each design change.	J.Barry/J.Davis	All design changes evaluated in Digital Buck with designer.	10	2	2	40
				YC	[4.1.5] Foreign objects lodge in strg system or to adjacent components	2			Vehicle Durbility Test Vehicle Corrosion Test Clearance check Design aid buck	5	100	[4.1.5.1] Protect I-shaft to gear connection.	T Blazer	Plastic collar on I-shaft to gear connection.	10	2	2	40
				YC	[4.1.6] Steering Lock-up during Driving.	2			Joint Analysis Torque / Angle Test Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS (SG-0065: Linkage	3	60	[4.1.6.1] Review ADAMS data.	J.Barry	ADAMS geometry analysis confirms no lock up condition.	10	1	2	20

							Toggling)									
				YC	[4.1.7] Failure of Adjustment Travel Limiters.	3	Component DVP&R Component FMEA - Ref. Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Fatigue Test Ultimate Strength Test Efforts Test	3	90	[4.1.7.1] None at this time						
				YC	[4.1.8] Improper joint connections at: Column to Upper I-shaft; Upr I-shaft to Lwr I-shaft; Lwr I-shaft to Gear; Gear to Frame; Tie Rod to Knuckle; Strg Wheel to Column	2	CAE VE5C3C-3504-AA Section III.J-Block Cycle Fatigue (Visteon Gear DVP) VE5C3C-3504-AA Section III.H-Gear Impact (Visteon Gear DVP) Fastener torque-to-failure Fastener Torque/Angle Test R318/R360 Vehicle Durability Road load vehicle Inverted Delta items specified in WERS	3	60	[4.1.8.1] Increase steering gear to frame bolt size.	J.Barry	Increased steering gear bolt size to 14mm. Gear to frame test conducted.	10	2	2	40
[4.2] Intermittently converts angular to linear displacement (transmits torque).	Impaired vehicle control Damage to surrounding components	10	YC	[4.2.1] Steering column binding	2	CAE R318/R360 Vehicle Durability Fresh Eyes Reviews Compatibility Reviews See Column FMEA	2	40	[4.2.1.1] None at this time							
			YC	[4.2.2] Package interference	2	WCR clearance Design clearance checklist VSA studies Design Aid buck Fresh Eyes Reviews Compatibility Reviews R318/R360 Vehicle Durability	2	40	[4.2.2.1] Perform clearance/interference check after each design change.	J.Barry/J.Davis	All design changes evaluated in Digital Buck with designer.	10	2	2	40
			YC	[4.2.3] Gear system defects	2	CAE VE5C3C-3504-AA Section III.J-Block Cycle Fatigue (Visteon Gear DVP) VE5C3C-3504-AA Section III.H-Gear Impact (Visteon Gear DVP) R318/R360 Vehicle Durability See Gear FMEA	2	40	[4.2.3.1] Increase sector shaft diameter. Review Gear FMEA	J.Barry J.Barry 3-Jan-2003 OVERDUE	Sector shaft diameter increased to 1 5/8". Testing confirms Steering gear FMEA reviewed and accepted by Supplier & Ford	10	1	2	20
			YC	[4.2.4] Foreign objects lodge in strg system or adjacent components	2	R318/R360 Vehicle Durability R311 Vehicle Corrosion Design Clearance Checklist Fresh Eyes Review	5	100	[4.2.4.1] Protect I-shaft to gear connection.	T Blazer	Plastic collar on I-shaft to gear connection.	10	2	2	40
[4.3] Inadequate output to knuckle (excessive compliance or improper ratio).	Degraded system function (sloppy / sticky / binding). Customer dissatisfaction. Does not fit vehicle effort image.	6	YS	[4.3.1] Excessive Gear / Linkage system friction &/or play.	4	Lab Functional Testing Component DVP&R Vehicle Development Testing Steering SDS CAE Analysis	2	48	[4.3.1.1] Improve tie rod end robustness.	J.Barry	Incorporated lube-for-life tie rod end design: - Neoprene boot seals - LT2/78 grease - Geomet coated	6	2	3	36

														studs Eliminated pin joints.				
					[4.3.2] Excessive column system compliance.	2	NVH Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Nibble Sensitivity Study Component DVP&R Road Load Vehicle Isolator Tuning CAE Analysis Modal Analysis Bed Plate Testing	3	36	[4.3.2.1] None at this time						
					[4.3.3] Suspension / Alignment defect.	3	Vehicle Development Testing NVH Vehicle Development Testing R318/R360 Vehicle Durability CAE Analysis Road Load testing Isolator Tuning Nibble Sensitivity Tuning Steering SDS	2	36	[4.3.3.1] None at this time						
					[4.3.4] Steering system tuning doesn"t meet customer"s expectations.	3	See Gear DVP&R See Gear FMEA Vehicle Development Testing Steering SDS	2	36	[4.3.4.1] Optimize gear characteristics.	J.Barry	Performed optimization of gear boost curve and T-bar.	6	3	2	36
	[4.4] Does not meet torque requirements for efforts w/o assist	Redesign required Deviation to WCR required System degraded	8		[4.4.1] Inadequate gear system ratio	3	vehicle development testing	3	72	[4.4.1.1] None at this time						
					[4.4.2] Inadequate mechanical advantage	3	vehicle development testing	3	72	[4.4.2.1] None at this time						
					[4.4.3] Excessive friction or inertia	2	vehicle development testing	3	48	[4.4.3.1] None at this time						
[5] Receive & convert feedback linear force to torque and convert linear displacement to angular displacement and transmit to user for road feel - Positive Road feel (in-lb; degrees).	[5.1] Does not receive feedback from knuckle.	Degraded system function. Damage to surrounding components. Customer dissatisfaction.	6	**YS**	[5.1.1] Excessive Gear / Linkage system friction & / or play.	4	Lab Functional Testing Component DVP&R Vehicle Development Testing Steering SDS	2	48	[5.1.1.1] Improve tie rod end robustness.	J.Barry	Incorporated lube-for-life tie rod end design: - Neoprene boot seals - LT2/78 grease - Geomet coated studs Eliminated pin joints.	6	2	3	36
				YS	[5.1.2] Suspension / Alignment / Column defect.	4	Vehicle Development Testing NVH Vehicle Development Testing R318/R360 Vehicle Durability CAE Analysis Road Load testing Isolator Tuning Nibble Sensitivity Tuning Steering SDS	3	72	[5.1.2.1] None at this time						
	[5.2] Does not convert feedback from knuckle	Impaired vehicle control(10)	10	**YC**	[5.2.1] Gear system defects	2	CAE VE5C3C-3504-AA Section III.J-Block Cycle Fatigue (Visteon Gear DVP)	2	40	[5.2.1.1] Increase sector shaft diameter.	J.Barry	Sector shaft diameter increased to 1 5/8". Testing confirms	10	1	2	20

							VE5C3C-3504-AA Section III.H-Gear Impact (Visteon Gear DVP) R318/R360 Vehicle Durability See Gear FMEA			Review Gear FMEA	J.Barry 3-Jan-2003 OVERDUE	Steering gear FMEA reviewed and accepted by Supplier & Ford				
			YC	[5.2.2] Column system defect	2		CAE Column Structural Fatigue Bi-Directional Durability R318/R360 Vehicle Durability See Column FMEA See Column DVP	3	60	[5.2.2.1] None at this time						
[5.3] Partial / non-linear / uneven feedback from knuckle converted (downstream compliance, friction & off-set mass).	Degraded system function. Premature tire wear. Potential misdiagnosis of repair requirement. Customer dissatisfaction.	6		[5.3.1] Excessive Suspension / column compliance.	3		NVH Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Nibble Sensitivity Study Component DVP&R Road Load Vehicle Isolator Tuning CAE Analysis Modal Analysis Bed Plate Testing	3	54	[5.3.1.1] None at this time						
				[5.3.2] Off-set mass in steering wheel (Air-bag).	2		Vehicle Development Testing Column System Friction Nibble Sensitivity Testing	4	48	[5.3.2.1] None at this time						
			YS	[5.3.3] Excessive Gear / linkage system friction & / or Play.	4		Lab Functional Testing Component DVP&R Vehicle Development Testing Steering SDS	2	48	[5.3.3.1] Improve tie rod end robustness.	J.Barry	Incorporated lube-for-life tie rod end design: - Neoprene boot seals - LT2/78 grease - Geomet coated studs Eliminated pin joints.	6	2	3	36
				[5.3.4] Excessive steering system dampening.	2		Vehicle Development Testing NVH Vehicle Development Testing R318/R360 Vehicle Durability CAE Analysis Road Load testing Isolator Tuning Nibble Sensitivity Tuning	2	24	[5.3.4.1] None at this time						
[5.4] Excessive feedback of outside force (nibble & wheel- fight).	Degraded system function. Potential misdiagnosis of repair requirement. Customer discomfort.	6		[5.4.1] Improper or defective tire/wheel mounting.	2		Vehicle Development Testing NVH Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Road Load testing Design Aid Buck WCR Clearance CAD Checks	3	36	[5.4.1.1] None at this time						
			YS	[5.4.2] Inadequate Gear / linkage system friction /	4		Lab Functional Testing Component DVP&R	2	48	[5.4.2.1] Improve dampening of system.		Dampers released on	6	3	2	36

				dampening.		Vehicle Development Testing Steering SDS					100% of vehicles.
				[5.4.3] Tire imbalance / Mis-alignment.	3	Vehicle Development Testing Alignment Studies Road Load testing Pilot Build	2	36	[5.4.3.1] None at this time		
				[5.4.4] Excessive Suspension sensitivity.	3	Vehicle Development Testing NVH Vehicle Development Testing R318/R360 Vehicle Durability CAE Analysis Road Load testing Isolator Tuning Nibble Sensitivity Tuning Steering SDS	2	36	[5.4.4.1] None at this time		
[6] Isolates the Driver from Road Harshness & Driveline Input (accelaration).	[6.1] Does not isolate the driver from road harshness and driveline input.	Customer dissatisfaction. Failure to meet program targets.	6	[6.1.1] External non-column part contacts column or I-shaft.	2	Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Vehicle Corrosion Testing Clearance Check Design Aid Buck	3	36	[6.1.1.1] None at this time		
				[6.1.2] Grounded shaft isolator.	2	NVH Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Nibble Sensitivity Study Component DVP&R Road Load Vehicle Isolator Tuning CAE Analysis Modal Analysis Bed Plate Testing	3	36	[6.1.2.1] None at this time		
				[6.1.3] Missing boot or misalignment.	2	NVH Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Nibble Sensitivity Study Component DVP&R Road Load Vehicle Isolator Tuning CAE Analysis Modal Analysis Bed Plate Testing	2	24	[6.1.3.1] None at this time		
				[6.1.4] Unintended column excitation.	2	NVH Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Nibble Sensitivity Study Component DVP&R Road Load Vehicle Isolator Tuning CAE Analysis Modal Analysis Bed Plate Testing	4	48	[6.1.4.1] None at this time		
				[6.1.5] Failed or torn isolator.	2	NVH Vehicle Development Testing R318/R360 Vehicle	2	24	[6.1.5.1] None at this time		

					Durability Steering SDS Nibble Sensitivity Study Component DVP&R Road Load Vehicle Isolator Tuning CAE Analysis Modal Analysis Bed Plate Testing			
			[6.1.6] Low Pump Flow	2	Component DVP&R Component FMEA - Ref. R318/R360 Vehicle Durability Cold Start Lab Testing Cold Start Vehicle Testing Lab Durability Testing	2	24	[6.1.6.1] None at this time
			[6.1.7] Gear Reverse Efficiency too High	2	Component DVP&R Component FMEA - Ref. R318/R360 Vehicle Durability Lab Durability Testing	2	24	[6.1.7.1] None at this time
			[6.1.8] Too much noise in the Pressure Hose Assembly	3	Vehicle Development Testing NVH Vehicle Development Testing R318/R360 Vehicle Durability CAE Analysis Road Load testing Isolator Tuning Nibble Sensitivity Tuning 2 Steering SDS	2	36	[6.1.8.1] None at this time
[6.2] To much isolation from road inputs.	Customer dissatisfaction. Failure to meet program targets.	6	[6.2.1] Detirioration of ioslator material.	3	NVH Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Nibble Sensitivity Study Component DVP&R Road Load Vehicle Isolator Tuning CAE Analysis Modal Analysis Bed Plate Testing	2	36	[6.2.1.1] None at this time
			[6.2.2] Too high Pump flow	2	Component DVP&R Component FMEA - Ref. R318/R360 Vehicle Durability Lab Durability Testing	2	24	[6.2.2.1] None at this time
			[6.2.3] Too low Reverse Efficiency	2	Component DVP&R Component FMEA - Ref. R318/R360 Vehicle Durability Lab Durability Testing	2	24	[6.2.3.1] None at this time
			[6.2.4] Too high Friction in Steering Gear	2	Component DVP&R Component FMEA - Ref. R318/R360 Vehicle Durability Lab Durability Testing	2	24	[6.2.4.1] None at this time

				[6.2.5] Failed or torn isolator.	2	NVH Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Nibble Sensitivity Study Component DVP&R Road Load Vehicle Isolator Tuning CAE Analysis Modal Analysis Bed Plate Testing	2	24	[6.2.5.1] None at this time					
[7] Provide Returnability of the Steering Wheel (degrees/second).	[7.1] No self returnability.	Will require driver"s input to recover from vehicle turn. Customer dissatisfaction.	8	[7.1.1] Damage / Wear of the Gear System.	3	VE5C3C-3504-AA Section III.J-Block Cycle Fatigue (Visteon Gear DVP) VE5C3C-3504-AA Section III.H-Gear Impact (Visteon Gear DVP) VE5C3C-3504-AA Section III.C-Sector Torque Cycling (Visteon Gear DVP) R318/R360 Vehicle Durability Gear Attachment Testing Efforts Test See Gear FMEA	3	72	[7.1.1.1] Improve gear robustness.	1 5/8" sector shaft at 2X road load requirement. M14 bolts used for attachment of gear to frame. Optimized boost curve.	8	2	2	32
				[7.1.2] Damage / Wear of the Pump System.	2	See Pump DVP&R See Pump FMEA R318/R360 Vehicle Durability Cold Start Lab Testing Cold Start Vehicle Testing Lab Durability Testing	2	32	[7.1.2.1] None at this time					
				[7.1.3] Damage / Wear of the Hydraulic Distribution System.	3	R318/R360 Vehicle Durability Hydraulic Distribution DVP&R Hydraulic Distribution FMEA Power Steering Fluid Spec. Material Testing Impulse Testing Cold Room Testing	3	72	[7.1.3.1]	Added clips to hoses/tubes for better retention. Increased tube wall thickness. Added pop clamps.	8	2	2	32
				[7.1.4] Binding in steering system.	2	Efforts Test WCR Clearance Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Component FMEA - Ref. Design Aid Buck	3	48	[7.1.4.1] None at this time					
				[7.1.5] Vehicle geometry	2	Vehicle Development Testing Current Design Practice CAE Analysis VSA Studies Road Load Test Design AId Buck	4	64	[7.1.5.1]	Increased caster and KPI. Reduced scrub radius.	8	2	2	32
				[7.1.6] Too much compliance in strg system	3	Gear Attachment Test Vehicle Development	4	96	[7.1.6.1]	Eliminated rubber	8	2	3	48

				Test R310 Durability Test Component DVP&R Steering SDS					encapsulated joint from linkage.				
			[7.1.7] Too much friction in system.	2	Lab Functional Test Component DVP&R Vehicle Development Test R318/R360 Durability Testing Steering SDS	3	48	[7.1.7.1] None at this time					
			[7.1.8] Contamination in the Pump or Gear.	2	P/S Contamination Spec. Vehicle Development Testing R318/R360 Vehicle Durability Efforts Test See Pump & Gear FMEA"s	4	64	[7.1.8.1] Better supplier and assembly plant controls of contamination.	TBD					
			[7.1.9] Loss of Fluid.	3	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Cold Room Testing Steering SDS Constant Tension Clamp Spec. Full Lock System Integrity	3	72	[7.1.9.1]		Added clips to hoses/tubes for better retention. Designed hose joints to design guide standards. Added pop clamps.	8	2	2	32
			[7.1.10] Stalled Engine.	2	Steering SDS R318/R360 Vehicle Durability Current Design Practice Component DVP&R Material Specs.	2	32	[7.1.10.1] None at this time						
			[7.1.11] FEAD / Pump Pulley Belt Slippage / Belt Breakage.	2	Steering SDS R318/R360 Vehicle Durability Current Design Practice Component DVP&R Material Specs.	2	32	[7.1.11.1] None at this time						
			[7.1.12] High Fluid Viscosity / High back pressure at very Low Temperatures.	2	Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Cold Room Vehicle Testing Evac. & Fill	3	48	[7.1.12.1] None at this time						
[7.2] Slow self returnability.	May require driver input to recover from turn. Customer Dissatisfaction.	6	[7.2.1] Damage / Wear of the Gear System.	3	VE5C3C-3504-AA Section III.J-Block Cycle Fatigue (Visteon Gear DVP) VE5C3C-3504-AA Section III.H-Gear Impact (Visteon Gear DVP) VE5C3C-3504-AA Section III.C-Sector Torque Cycling (Visteon Gear DVP) R318/R360 Vehicle Durability Gear Attachment Testing Efforts Test	3	54	[7.2.1.1]		1 5/8" sector shaft at 2X road load requirement. M14 bolts used for attachment of gear to frame. Optimized boost curve.	6	2	2	24

		See Gear FMEA									
[7.2.2] Damage / Wear of the Pump System.	2	See Pump DVP&R See Pump FMEA R318/R360 Vehicle Durability Cold Start Lab Testing Cold Start Vehicle Testing Lab Durability Testing	2	24	[7.2.2.1] None at this time						
[7.2.3] Damage / Wear of the Hydraulic Distribution System.	3	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Impulse Testing Cold Room Testing	3	54	[7.2.3.1]	Added clips to hoses/tubes for better retention. Increased tube wall thickness. Added pop clamps.	6	2	2	24
[7.2.4] Gear Binding.	2	Fatigue Test Max. Input Torque Brinell Test Impact Test Gear Attachment Testing Efforts Test	3	36	[7.2.4.1] None at this time						
[7.2.5] Column Binding.	2	Efforts Test WCR Clearance Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Component FMEA - Ref. Design Aid Buck	3	36	[7.2.5.1] None at this time						
[7.2.6] Vehicle geometry.	2	Vehicle Development Testing Current Design Practice CAE Analysis VSA Studies Road Load Test Design Aid Buck	4	48	[7.2.6.1]	Increased caster and KPI. Reduced scrub radius.	6	2	2	24
[7.2.7] Too much friction in system.	2	Lab Functional Testing Component DVP&R Vehicle Development Testing Steering SDS	3	36	[7.2.7.1] None at this time						
[7.2.8] Incorrectly specified boost curve and t-bar.	2	Lab Functional Test Cold Start Lab Test Cold Start Vehicle Test Component DVP&R Component FMEA - Ref. Steering SDS Catch-up Test	2	24	[7.2.8.1] None at this time						
[7.2.9] Too much compliance in strg system.	3	Gear Attachment Test Vehicle Development Test R310 Durability Test Component DVP&R Steering SDS	4	72	[7.2.9.1]	Eliminated the rubber encapsulated joint from linkage.	6	2	3	36
[7.2.10] Offset mass in wheel.	2	Vehicle Development Testing Column System Friction	4	48	[7.2.10.1] None at this time						

						Nibble Sensitivity Testing										
			[7.2.11] U-joint phasing inadequate.	2		Joint Analysis Torque / Angle Test Vehicle Development Test R310 Durability Test Steering SDS	5	60	[7.2.11.1]		U-joint phasing less than 2% (vs. 5% target).	6	2	2	24
			[7.2.12] Excessive Suspension / Linkage Friction.	2		Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Component DVP&R Component FMEA - Ref.	3	36	[7.2.12.1] None at this time						
			[7.2.13] Contamination in the Pump or Gear.	2		Power Steering Contamination Spec. on Print Vehicle Development Testing R318/R360 Vehicle Durability Efforts Test Component FMEA - Ref.	4	48	[7.2.13.1] Better supplier and plant controls for contamination.	TBD					
			[7.2.14] Loss of Fluid.	3		R318/R360 Vehicle Durability Cold Temperature Testing Component DVP&R Component FMEA - Ref. Tolerance Studies Power Steering Contamination Spec. on Print Constant Tension Clamp Spec. Full Lock System Integrity	4	72	[7.2.14.1]		Added clips to hoses/tubes for better retention. Designed hose joints to design guide standards. Added pop clamps.	6	2	2	24
			[7.2.15] FEAD / Pump Pulley Belt Slippage.	2		Steering SDS R318/R360 Vehicle Durability Current Design Practice Component DVP&R Material Specs.	2	24	[7.2.15.1] None at this time						
			[7.2.16] High Fluid Viscosity / High back pressure at very Low Temperatures.	2		Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Cold Room Vehicle Testing Evac. & Fill	3	36	[7.2.16.1] None at this time						
[7.3] Inconsistent Returnability.	May require driver input to recover from turn. Customer Dissatisfaction.	7	[7.3.1] Damage / Wear of the Gear System.	3		VE5C3C-3504-AA Section III.J-Block Cycle Fatigue (Visteon Gear DVP) VE5C3C-3504-AA Section III.H-Gear Impact (Visteon Gear DVP) VE5C3C-3504-AA Section III.C-Sector Torque Cycling (Visteon Gear DVP)	3	63	[7.3.1.1]		1 5/8" sector shaft at 2X road load requirement. M14 bolts used for attachment of gear to frame. Optimized boost curve.	7	2	2	28

			R318/R360 Vehicle Durability Gear Attachment Testing Efforts Test See Gear FMEA									
[7.3.2] Damage / Wear of the Pump System.	2		See Pump DVP&R See Pump FMEA R318/R360 Vehicle Durability Cold Start Lab Testing Cold Start Vehicle Testing Lab Durability Testing	2	28	[7.3.2.1] None at this time						
[7.3.3] Damage / Wear of the Hydraulic Distribution System.	3		R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Impulse Testing Cold Room Testing	3	63	[7.3.3.1]	Added clips to hoses/tubes for better retention. Increased tube wall thickness. Added pop clamps.	7	2	2	28
[7.3.4] Gear Binding.	2		Fatigue Test Max. Input Torque Brinell Test Impact Test Gear Attachment Testing Efforts Test	3	42	[7.3.4.1] None at this time						
[7.3.5] Column Binding.	2		Efforts Test WCR Clearance Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Component FMEA - Ref. Design Aid Buck	3	42	[7.3.5.1] None at this time						
[7.3.6] Excessive Gear Friction.	2		Lab Functional Testing Component DVP&R Vehicle Development Testing Steering SDS	3	42	[7.3.6.1] None at this time						
[7.3.7] Excessive Suspension / Linkage Friction.	2		Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Component DVP&R Component FMEA - Ref.	3	42	[7.3.7.1] None at this time						
[7.3.8] Contamination in the Pump or Gear.	2		Power Steering Contamination Spec. Vehicle Development Testing R318/R360 Vehicle Durability Efforts Test Component FMEA - Ref.	4	56	[7.3.8.1] Better supplier and assembly plant controls for contamination.	TBD					
[7.3.9] FEAD / Pump Pulley Belt Slippage.	2		Steering SDS R318/R360 Vehicle	2	28	[7.3.9.1] None at this time						

							Durability Current Design Practice Component DVP&R Material Specs.										
	[7.4] Fast Returnability.	Customer Discomfort.	6		[7.4.1] Excessive Suspension / Linkage restoring force.	2	Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Component DVP&R Component FMEA - Ref.	3	36	[7.4.1.1] None at this time							
					[7.4.2] Vehicle geometry.	2	Vehicle Development Testing Current Design Practice CAE Analysis VSA Studies Road Load Test Design Aid Buck	4	48	[7.4.2.1] None at this time							
					[7.4.3] Too low friction in system.	2	Lab Functional Test Component DVP&R Vehicle Development Test Steering SDS	3	36	[7.4.3.1] None at this time							
					[7.4.4] Incorrectly specified boost curve and t-bar.	2	Lab Functional Test Cold Start Lab Test Cold Start Vehicle Test Component DVP&R Component FMEA - Ref. Steering SDS Catch-up Test	2	24	[7.4.4.1] None at this time							
					[7.4.5] Too much compliance in strg system.	3	Gear Attachment Test Vehicle Development Test R310 Durability Test Component DVP&R Steering SDS	3	54	[7.4.5.1]	Removed rubber encapsulated joint from linkage.	6	2	2	24
					[7.4.6] Offset mass in wheel.	2	Vehicle Development Testing Column System Friction Nibble Sensitivity Testing	4	48	[7.4.6.1] None at this time							
					[7.4.7] U-joint phasing inadequate.	2	Joint Analysis Torque / Angle Test Vehicle Development Test R310 Durability Test Steering SDS	5	60	[7.4.7.1]	Phasing is less than 2% (vs. 5% target).	6	2	2	24
				YS	[7.4.8] Loss of power steering fluid.	4	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Cold Room Testing Tolerence Studies Power Steering Contamination Spec. Constant Tension Clamp Spec. Full Lock System Integrity	4	96	[7.4.8.1]	Added clips to hoses/tubes for better retention. Increased tube wall thickness. Added pop clamps.	6	2	2	24
[8] Provide Power Assist - Reduce Steering Efforts (in-lb).	[8.1] Zero Assist - Full Loss of Power Assist.	Increased Steering Efforts due to complete loss of Power Assist.	8	YS	[8.1.1] Loss of Fluid due to Leaks, Blow-out of Hoses, etc...	4	R318/R360 Vehicle Durability Component DVP&R	3	96	[8.1.1.1]	Added clips to hoses/tubes for better retention.	8	3	2	48

Increased Brake Effort due to complete loss of Power Assist to the Hydroboost System. Customer Dissatisfaction.			Component FMEA - Ref. Cold Room Testing Tolerence Studies Power Steering Contamination Spec. Constant Tension Clamp Spec. Full Lock System Integrity				Increased tube wall thickness. Designed hose joints to design guide requirements. Added pop clamps. Higher pressure hose material for 1850 psi system pressure.					
	[8.1.2] Damage / Wear of Pump System.	3	Component DVP&R Component FMEA - Ref. R318/R360 Vehicle Durability Cold Start Lab Testing Cold Start Vehicle Testing Lab Durability Testing	2	48	[8.1.2.1] None at this time						
	[8.1.3] Damage / Wear of the Hydroboost System.	2	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Cold Room Testing Tolerence Studies Power Steering Contamination Spec. Lab Durability Testing Full Lock System Integrity	4	64	[8.1.3.1] Recommend usage of 10 micron filter in the steering system	10 micron filter is reservoir.	8	2	2	32	
	[8.1.4] Damage / Wear of Gear System.	3	Fatigue Test Max. Input Torque Brinell Test Impact Test Gear Attachment Testing Efforts Test	3	72	[8.1.4.1]	Lowered splines from seal area.	8	3	2	48	
	[8.1.5] Damage / Wear of Hydraulic Distribution System.	3	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Impulse Testing Cold Room Testing	3	72	[8.1.5.1]	Added clips to hoses/tubes for better retention. Increased tube wall thickness. Added pop clamps.	8	2	2	32	
	[8.1.6] Contamination of Pump & Gear System (Valve Stiction &/or Seal Damage).	2	Power Steering Contamination Spec. Vehicle Development Testing R318/R360 Vehicle Durability Efforts Test Component FMEA - Ref.	4	64	[8.1.6.1] Better supplier and assembly plant controls for contamination.						
	[8.1.7] Fluid Breakdown due to Excessive Temperature or Water Contamination.	2	TASE Vehicle Development Testing Steering SDS Power Steering Fluid Spec.	8	128	[8.1.7.1]	Larger cooler released. Cooler relocated to fan airstream.	8	2	3	48	

						Evac. & Fill Component DVP&R Component FMEA - Ref. Power Steering Contamination Spec.								
				[8.1.8] Material Failure due to Corrosion, Excessive Heat, Pressure, etc...	2	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. R311 Vehicle Corrosion Testing Material Specs. Current Design Practice	3	48	[8.1.8.1] None at this time ********** Recall 88M63					
				[8.1.9] Stalled Engine.	2	Steering SDS R318/R360 Vehicle Durability Current Design Practice Component DVP&R Material Specs.	3	48	[8.1.9.1] None at this time ********** Recall # 81421					
				[8.1.10] FEAD / Pump Pulley Belt Slippage / Belt Breakage / Belt Jumps.	2	Steering SDS R318/R360 Vehicle Durability Current Design Practice Component DVP&R Material Specs.	2	32	[8.1.10.1] None at this time ********** Recall # 89M69, 96B82, 93B34					
				[8.1.11] Pump pulley joint failure.	2	Steering SDS R318/R360 Vehicle Durability Current Design Practice Component DVP&R Material Specs.	2	32	[8.1.11.1] None at this time ********** Recall # 89B87					
				[8.1.12] High fluid viscosity / high back Pressure in Low Temperature Conditions.	2	Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Cold Room Vehicle Testing Evac. & Fill	3	48	[8.1.12.1] None at this time					
				[8.1.13] Connector / Fittings / Attachment Failure.	3	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Impulse Testing Cold Room Testing	5	120	[8.1.13.1]	Pop clamps released. Designed hose joints to design guide requirements.	8	2	2	32
[8.2] Intermittent Loss of Power Assist.	Uneven Efforts. Customer Dissatisfaction.	7	**YS**	[8.2.1] Air Ingestion.	4	Steering SDS Power Steering Fluid Spec. Evac. & Fill Component DVP&R Component FMEA - Ref. Cold Weather Vehicle Testing	4	112	[8.2.1.1]	Round reservoir with tangential entry released.	7	2	3	42

[8.2.2] Contamination of Pump & Gear System.	2	Power Steering Contamination Spec. Vehicle Development Testing R318/R360 Vehicle Durability Efforts Test Component FMEA - Ref.	4	56	[8.2.2.1] Better supplier and assembly plant controls for contamination.	TBD						
[8.2.3] Damage / Wear of Pump System.	2	Component DVP&R Component FMEA - Ref. R318/R360 Vehicle Durability Cold Start Lab Testing Cold Start Vehicle Testing Lab Durability Testing	2	28	[8.2.3.1] None at this time							
[8.2.4] Damage / Wear of the Hydroboost System.	2	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Cold Room Testing Tolerence Studies Power Steering Contamination Spec. Lab Durability Testing Full Lock System Integrity	4	56	[8.2.4.1] Recommend usage of 10 micron filter in the steering system		10 micron filter in reservoir.	7	2	2	28
[8.2.5] Damage / Wear of Gear System.	3	Fatigue Test Max. Input Torque Brinell Test Impact Test Gear Attachment Testing Efforts Test	3	63	[8.2.5.1]		Lowered splines from seal area.	7	3	2	42
[8.2.6] FEAD / Pump Pulley Belt Slippage.	2	Steering SDS R318/R360 Vehicle Durability Current Design Practice Component DVP&R Material Specs.	2	28	[8.2.6.1] None at this time							
[8.2.7] Steering Wheel Speed Overtaking Hydraulic Assist.	3	Vehicle Development Testing R318/R360 Vehicle Durability Catch-up Test Pump Sizing Calculation Component DVP&R Component FMEA - Ref. Steering SDS Cold Weather Vehicle Testing	2	42	[8.2.7.1] None at this time							
[8.2.8] Contamination of Hydraulic Distribution System.	2	Power Steering Contamination Spec. Vehicle Development Testing R318/R360 Vehicle Durability Efforts Test Component FMEA - Ref.	4	56	[8.2.8.1] Better supplier and assembly plant controls for contamination.	TBD						

			[8.2.9] Inadequate Pump flow or Pump Pressure for Steering System requirements.	2	Vehicle Development Testing R318/R360 Vehicle Durability Catch-up Test Pump Sizing Calculation Component DVP&R Component FMEA - Ref. Steering SDS Cold Weather Vehicle Testing	2	28	[8.2.9.1] None at this time						
			[8.2.10] Packaging Constraints (Reservoir to Pump distance / location, Hose diameter).	2	WCR Clearance VSA Studies Design Aid Buck Clearance Studies R318/R360 Vehicle Durability Tolerence Stack-up	3	42	[8.2.10.1] None at this time						
			[8.2.11] Unstable Gear-Pump interaction.	2	Lab Functional Testing Cold Start Lab Testing Cold Start Vehicle Testing Component DVP&R Component FMEA - Ref. Steering SDS Catch-up Test	4	56	[8.2.11.1]	Pump flow less than 4 gpm (Visteon gear instability target).	7	2	2	28
[8.3] Over Assist.	System degradation (pressure, Temperature,...). Low steering efforts. Customer dissatisfaction.	6	[8.3.1] Damage / Wear of the Pump System.	2	See Pump DVP&R See Pump FMEA R318/R360 Vehicle Durability Cold Start Lab Testing Cold Start Vehicle Testing Lab Durability Testing	2	24	[8.3.1.1] None at this time						
			[8.3.2] Damage / Wear of the Gear System.	2	VE5C3C-3504-AA Section III.J-Block Cycle Fatigue (Visteon Gear DVP) VE5C3C-3504-AA Section III.H-Gear Impact (Visteon Gear DVP) VE5C3C-3504-AA Section III.C-Sector Torque Cycling (Visteon Gear DVP) R318/R360 Vehicle Durability Gear Attachment Testing Efforts Test See Gear FMEA	2	24	[8.3.2.1] None at this time						
			[8.3.3] Contamination of the Pump & Gear System.	2	Power Steering Contamination Spec. Vehicle Development Testing R318/R360 Vehicle Durability Efforts Test Component FMEA - Ref.	4	48	[8.3.3.1] Better supplier and assembly plant controls for contamination.	TBD					
			[8.3.4] Service fluid not to Ford specification.	3	TASE Vehicle Development Testing Steering SDS	3	54	[8.3.4.1] None at this time						

						Power Steering Fluid Spec. Evac. & Fill Component DVP&R Component FMEA - Ref. Power Steering Contamination Spec.								
				[8.3.5] Fast steering system response time due to: - Distribution system - Pump system - Gear system.	2	Lab Functional Testing Component DVP&R Component FMEA - Ref. Steering SDS Vehicle Development Testing R318/R360 Vehicle Durability	3	36	[8.3.5.1] None at this time						
[8.4] Under Assist	Increased steering efforts. Increased braking efforts. Degraded system function. Customer dissatisfaction.	6		[8.4.1] Reduced flow from damage / Wear of Pump System.	3	Vehicle Development Testing R318/R360 Vehicle Durability Catch-up Test Pump Sizing Calculation Component DVP&R Component FMEA - Ref. Steering SDS Cold Weather Vehicle Testing	2	36	[8.4.1.1] None at this time						
				[8.4.2] Reduced flow from damage / Wear / restriction of Hydraulic Distribution System.	3	Vehicle Development Testing R318/R360 Vehicle Durability Catch-up Test Pump Sizing Calculation Component DVP&R Component FMEA - Ref. Steering SDS Cold Weather Vehicle Testing	3	54	[8.4.2.1] None at this time						
				[8.4.3] Damage / Wear of Gear System.	3	Fatigue Test Max. Input Torque Brinell Test Impact Test Gear Attachment Testing Efforts Test	2	36	[8.4.3.1] None at this time						
				[8.4.4] Contamination of Pump (valve Stiction).	2	Power Steering Contamination Spec. Vehicle Development Testing R318/R360 Vehicle Durability Efforts Test Component FMEA - Ref.	4	48	[8.4.4.1] Better supplier and assembly plant controls for contamination.	TBD					
			YS	[8.4.5] Contamination of Gear (Seal Damage / Scoring).	5	Power Steering Contamination Spec. Vehicle Development Testing R318/R360 Vehicle Durability Efforts Test	5	150	[8.4.5.1] Tear Down Analysis		Lowered splines from seal area.	6	3	2	36

			Component FMEA - Ref.												
	[8.4.6] Contamination of Inline filters / filter screen in the reservoir.	2	Power Steering Contamination Spec. Vehicle Development Testing R318/R360 Vehicle Durability Efforts Test Component FMEA - Ref.	3	36	[8.4.6.1] None at this time								
YS	[8.4.7] Fluid Leakage.	6	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Cold Room Testing Tolerence Studies Power Steering Contamination Spec. Constant Tension Clamp Spec. Full Lock System Integrity	4	144	[8.4.7.1]		Added clips to hoses/tubes for better retention. Designed hose joints to design guide requirements. Added pop clamps.	6	3	2	36
	[8.4.8] Fluid Breakdown due to Water Contamination, High Temperature, etc.	3	Component DVP&R TASE Vehicle Development Testing Steering SDS Power Steering Fluid Spec. Evac. & Fill Component DVP&R Component FMEA - Ref. Power Steering Contamination Spec.	7	126	[8.4.8.1]		Larger cooler and moved into fan airstream.	6	2	3	36
YS	[8.4.9] Low Fluid Levels.	5	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Cold Room Testing Tolerence Studies Power Steering Contamination Spec. Constant Tension Clamp Spec. Full Lock System Integrity	3	90	[8.4.9.1] Recalibrate Evac & Fill equipment.	Dominion/T Bland		6	3	2	36
	[8.4.10] Service fluid not to Ford specification.	3	Component DVP&R TASE Vehicle Development Testing Steering SDS Power Steering Fluid Spec. Evac. & Fill Component DVP&R Component FMEA - Ref. Power Steering Contamination Spec.	3	54	[8.4.10.1] None at this time						
	[8.4.11] FEAD / Pump Pulley Belt Slippage.	2	Steering SDS R318/R360 Vehicle Durability Current Design Practice	2	24	[8.4.11.1] None at this time						

						Component DVP&R Material Specs.			
				[8.4.12] Slow steering system response time due to: - Distribution system - Pump system - Gear system.	2	Lab Functional Testing Cold Start Lab Testing Cold Start Vehicle Testing Component DVP&R Component FMEA - Ref. Steering SDS Catch-up Test	3	36	[8.4.12.1] None at this time
				[8.4.13] High fluid viscosity / High back pressure at low temperature conditions.	2	Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Cold Room Vehicle Testing Evac. & Fill	3	36	[8.4.13.1] None at this time
[9] Manage steering efforts to levels that match the functional image of the vehicle (Torque).	[9.1] High efforts.	Customer dissatisfaction. Degraded system performance.	6	[9.1.1] Excessive Gear / linkage system friction.	2	Lab Functional Testing Component DVP&R Vehicle Development Testing Steering SDS	3	36	[9.1.1.1] None at this time
				[9.1.2] Suspension / Alignment defect.	2	Vehicle Development Testing NVH Vehicle Development Testing R318/R360 Vehicle Durability CAE Analysis Road Load testing Isolator Tuning Nibble Sensitivity Tuning Steering SDS	3	36	[9.1.2.1] None at this time
				[9.1.3] Steering system tuning	2	Vehicle Development Testing NVH Vehicle Development Testing R318/R360 Vehicle Durability CAE Analysis Road Load testing Isolator Tuning Nibble Sensitivity Tuning	3	36	[9.1.3.1] None at this time
	[9.2] Low efforts.	Customer dissatisfaction. Degraded system performance.	6	[9.2.1] Suspension / Alignment defect.	2	Vehicle Development Testing NVH Vehicle Development Testing R318/R360 Vehicle Durability CAE Analysis Road Load testing Isolator Tuning Nibble Sensitivity Tuning Steering SDS	3	36	[9.2.1.1] None at this time
				[9.2.2] Steering system tuning.	2	Vehicle Development Testing NVH Vehicle Development Testing R318/R360 Vehicle	3	36	[9.2.2.1] None at this time

							Durability CAE Analysis Road Load testing Isolator Tuning Nibble Sensitivity Tuning								
	[9.3] Erratic efforts.	Customer dissatisfaction. Degraded system performance.	7		[9.3.1] Suspension / Alignment defect.	2	Vehicle Development Testing NVH Vehicle Development Testing R318/R360 Vehicle Durability CAE Analysis Road Load testing Isolator Tuning Nibble Sensitivity Tuning Steering SDS	3	42	[9.3.1.1] None at this time					
					[9.3.2] Erratic / uneven Gear / Linkage system Lash / free play.	2	Vehicle Development Testing Component DVP&R Component FMEA - Ref. Steering SDS Efforts Test	3	42	[9.3.2.1] None at this time					
				YS	[9.3.3] Mis-Alignment of Tie Rod End during alignment procedure. Socket located off-center of articulation window.	4		8	224	[9.3.3.1] Add use of tool/fixture in alignment pit to control orientation of tie rod end.	Assembly (KTP) 2-Jul-2004 OPEN	Tool implemented and interlocked to alignment pit acceptance criteria.	6	2	2	24
[10] Contain & Deliver Power Steering fluid such that the fluid will not leak on Heat Source (Pressure, Viscosity, Temperature).	[10.1] Power Steering Fluid Leaks on Heat Source.	Possible Ignition event.	10	YC	[10.1.1] Hose routing which allows for Power Steering fluid to leak on heat source.	2	Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Vehicle Corrosion Testing Clearance Check Design Aid Buck Vehicle Crash Test	2	40	[10.1.1.1]					
				YC	[10.1.2] Pump, Steering Gear or Reservoir location allows for fluid to leak on heat source	2	Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Vehicle Corrosion Testing Clearance Check Design Aid Buck Vehicle Crash Test	2	40	[10.1.2.1]					
[11] Contain & Deliver fluid with no external leaks for the Design life of the Vehicle - Pressure: 1850 psi - Temperature: -40 to 135 deg C	[11.1] Leaks at clamped joints - Reservoir Inlet - Reservoir Outlet - Pump Inlet - Cooler Inlet - Cooler Outlet - Hydroboost	Increased Steering Effort due to loss of Fluid. Increased Brake Effort due to Loss of Power Assist to the Hydroboost System. Pump Damage. System Noise. Air ingestion. Customer dissatisfaction. Possible higher fluid temperature.	6	YS	[11.1.1] Inadequate Tolerance between Hose & Connector due to different Co-efficients of Thermal Expansion.	6	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Cold Room testing Material Specs. Current Design Practice	2	72	[11.1.1.1]		Hose joints designed to design guide standards.	6	3	2	36
					[11.1.2] Hose disconnect due to excessive vibration.	3	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing	3	54	[11.1.2.1]		Added clips to hoses/tubes for better retention. Designed hose joints to design guide requirements.	6	3	2	36

					Impulse Testing Cold Room Testing Steering SDS										
			YS	[11.1.3] Inadequate Clamping Force due to Temperature Variation.	7	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Steering SDS Material Specs. Current Design Practice	3	126	[11.1.3.1]	Hose joints designed to design guide standards. Constant tension clamps used.	6	4	2	48
			YS	[11.1.4] Excessive Pressure.	4	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Impulse Testing Cold Room Testing	2	48	[11.1.4.1] None at this time					
			YS	[11.1.5] High Back Pressure / Parasitic losses.	5	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Impulse Testing Cold Room Testing	2	60	[11.1.5.1]	3/8" diameter tubes used.	6	4	2	48
				[11.1.6] Low Viscosity.	3	Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Cold Room Vehicle Testing Evac. & Fill	2	36	[11.1.6.1] None at this time					
			YS	[11.1.7] Inadequate friction between Hose material & Connector material / Coating due to Hose Aging.	4	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Material Specs. Current Design Practice	3	72	[11.1.7.1]	Designed hoses to design guide requirements.	6	3	2	36
			YS	[11.1.8] Material failure due to corrosion, excessive heat, etc.	4	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. R311 Vehicle Corrosion Testing Material Specs. Current Design Practice	3	72	[11.1.8.1]	Heat management test results reviewed. Below hose material heat requirement of 150 deg.	6	3	2	36
[11.2] Leak at Quick Connect / Tube-O / Banjo	Increased Steering Effort due to loss of Fluid. Increased Brake Effort due to Loss of Power Assist to the Hydroboost System.	6		[11.2.1] O-ring failure.	3	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. R311 Vehicle Corrosion Testing	2	36	[11.2.1.1] None at this time					

	Pump Damage. System noise. Air ingestion. Customer dissatisfaction. Possible higher fluid temperature.		YS	[11.2.2] Snap ring failure.	4	Material Specs. Current Design Practice R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. R311 Vehicle Corrosion Testing Material Specs. Current Design Practice	2	48	[11.2.2.1] None at this time
			YS	[11.2.3] Inadequate restraint of joint rotation.	4	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Impulse Testing Cold Room Testing	2	48	[11.2.3.1] None at this time
			YS	[11.2.4] Inadequate Torque.	4	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Impulse Testing Cold Room Testing	2	48	[11.2.4.1] None at this time
[11.3] Hydraulic Leak at Crimped Joints	Increased Steering Effort due to loss of Fluid. Increased Brake Effort due to Loss of Power Assist to the Hydroboost System. Pump Damage. Possible higher fluid temperature.	6		[11.3.1] Excessive Pressures.	3	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Impulse Testing Cold Room Testing	2	36	[11.3.1.1] None at this time
				[11.3.2] Perforation of Coupling Shell due to Corrosion.	3	Component DVP&R Component FMEA - Ref. R311 Vehicle Corrosion Testing Current Design Practice	2	36	[11.3.2.1] None at this time
			YS	[11.3.3] Service fluid not to Ford specification.	4	Component DVP&R TASE Vehicle Development Testing Steering SDS Power Steering Fluid Spec. Evac. & Fill Component DVP&R Component FMEA - Ref. Power Steering Contamination Spec.	2	48	[11.3.3.1] None at this time
[11.4] Fluid Leak thru" Reservoir Cap.	Possibly higher Steering Effort due to loss of Fluid.	6		[11.4.1] Reservoir Mount Failure.	3	Vehicle Development Testing NVH Vehicle	2	36	[11.4.1.1] None at this time

	Possibly higher Brake Effort due to Loss of Power Assist to the Hydroboost System. Pump Damage. Possible higher fluid temperature.					Development Testing R318/R360 Vehicle Durability Steering SDS Road Load testing Design Aid Buck WCR Clearance CAD Checks											
				[11.4.2] Excessive Vibration of the Reservoir.	3	Vehicle Development Testing NVH Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Road Load testing Design Aid Buck WCR Clearance CAD Checks	3	54	[11.4.2.1] Isolate Reservoir. Don"t mount Reservoir on Engine, in particular, on engines that vibrate excessively.		Reservior mounted on body structure with rubber isolators at each mount.	6	2	2	24
[11.5] Tube / Hose Burst.	Increased Steering Effort due to loss of Fluid. Increased Brake Effort due to Loss of Power Assist to the Hydroboost System. Pump Damage.	8		[11.5.1] Excessive Pressure.	2	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Impulse Testing Cold Room Testing	2	32	[11.5.1.1] None at this time							
				[11.5.2] Accelarated Hose Aging due to Thermal, Mechanical & Oxidative Environment.	2	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. R311 Vehicle Corrosion Testing Material Specs. Current Design Practice	3	48	[11.5.2.1] None at this time							
			YS	[11.5.3] Excessive Temperature induced by High Back Pressure.	4	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Impulse Testing Cold Room Testing	2	64	[11.5.3.1]		Larger cooler and in fan air stream. 3/8" tube diameter.	8	2	2	32
[11.6] Hose / Tube disconnect: - Quick connect - Clamped joint - Crimped joint - At any other endforms.	Increased Steering Effort due to loss of Fluid. Increased Brake Effort due to Loss of Power Assist to the Hydroboost System. Pump Damage.	8	YS	[11.6.1] Inadequate Tolerance between Hose & Connector due to different Co-efficients of Thermal Expansion.	6	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. R311 Vehicle Corrosion Testing Material Specs. Current Design Practice	2	96	[11.6.1.1] Review joint design guidelines	J.Barry	Designed hoses to design guide requirements.	8	3	2	48
				[11.6.2] Hose disconnect due to Vibration transmitted thru" P/S Components mounted on Sheetmetal or Engine.	3	Vehicle Development Testing NVH Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Road Load testing	3	72	[11.6.2.1]		Clips added to hoses for better retention.	8	2	2	32

			Design Aid Buck WCR Clearance CAD Checks											
	[11.6.3] Hose Vibration due to Bracket Failure.	2	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Impulse Testing Cold Room Testing	3	48	[11.6.3.1] None at this time							
	[11.6.4] Snap Ring Failure.	2	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Material Testing Impulse Testing Cold Room Testing	3	48	[11.6.4.1] None at this time							
	[11.6.5] Excessive Pressure Spikes.	3	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Impulse Testing Cold Room Testing	2	48	[11.6.5.1] None at this time							
YS	[11.6.6] High Back Pressure.	4	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Impulse Testing Cold Room Testing	2	64	[11.6.6.1]		3/8" diameter tubes used.	8	3	2	48
	[11.6.7] Excessive Turning of Quick Connect due to Vibration.	3	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Impulse Testing Cold Room Testing	2	48	[11.6.7.1] Add clip between pressure lines at hydroboost.	J.Davis 3-Aug-2003 OVERDUE						
YS	[11.6.8] Inadequate friction between Hose material & Connector material / Coating due to Hose Aging.	4	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. R311 Vehicle Corrosion Testing Material Specs. Current Design Practice	3	96	[11.6.8.1]		Designed hose joints to design guide requirements for interference fit.	8	3	2	48
YS	[11.6.9] Inadequate Clamping Force due to Hose material Hardening at Low Temperatures.	5	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Material Testing Impulse Testing Cold Room Testing	3	120	[11.6.9.1]		Designed hose joints to design guide requirements for interference fit.	8	3	2	48

[11.7] Hose / Tube kinked or bent.	Higher steering efforts. Higher braking efforts. Hose / tube disconnect. Possible system noise. Possibly higher temperature. Pump damage.	7	[11.7.1] Bracket failure.	2	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. R311 Vehicle Corrosion Testing Vibration Testing - Road Load Data Steering SDS	3	42	[11.7.1.1] None at this time						
			[11.7.2] Excessive skin temperature.	3	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Impulse Testing	2	42	[11.7.2.1] None at this time						
			[11.7.3] Damage due to external sources.	2	WCR Clearance VSA Studies Design Aid Buck Clearance Studies R318/R360 Vehicle Durability Tolerence Stack-up	3	42	[11.7.3.1] None at this time						
[11.8] Fluid Loss due to Hose Material Degradation.	Increased Steering Effort due to loss of Fluid. Increased Brake Effort due to Loss of Power Assist to the Hydroboost System. Pump Damage.	7	[11.8.1] Abrasion with Adjacent Components.	3	WCR Clearance VSA Studies Design Aid Buck Clearance Studies R318/R360 Vehicle Durability Tolerence Stack-up	3	63	[11.8.1.1]	Convolute or snake skin added to hoses. Clips added for better retention.	7	2	2	28
			[11.8.2] Heat Related Damage due to External Sources.	3	WCR Clearance VSA Studies Design Aid Buck Clearance Studies Heat Management Test R318/R360 Vehicle Durability Tolerence Stack-up	2	42	[11.8.2.1]						
			[11.8.3] Heat Related Damage due to Excessive Fluid Temperature.	3	TASE Vehicle Development Testing Steering SDS Power Steering Fluid Spec. Evac. & Fill Component DVP&R Component FMEA - Ref. Power Steering Contamination Spec.	2	42	[11.8.3.1] None at this time						
			[11.8.4] Accelarated Hose ageing due to oxidative environment.	2	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. R311 Vehicle Corrosion Testing Material Specs. Current Design Practice	3	42	[11.8.4.1] None at this time						
			[11.8.5] Inadequate restraint of Hose allowing movement into	3	R318/R360 Vehicle Durability Road Load Testing	3	63	[11.8.5.1]	Clips added for better retention of hoses.	7	2	2	28

					detrimental environment.		Steering SDS Corrosion Testing Component DVP&R Component FMEA - Ref.				Convolute or snake skin added.				
	[11.9] Corrosion.	Perforation of Tubes / Components. Possible loss of fluid.	6	YS	[11.9.1] Stone Pecking.	4	Component DVP&R Component FMEA - Ref. R311 Vehicle Corrosion Testing Current Design Practice	2	48	[11.9.1.1]	Cooler located at top of radiator support.	6	3	2	36
					[11.9.2] Underhood Fluids Leak like Battery acid, etc on P/S Tubes / Components.	2	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. R311 Vehicle Corrosion Testing Material Specs. Current Design Practice	3	36	[11.9.2.1] None at this time					
					[11.9.3] Road Salt.	2	Component DVP&R Component FMEA - Ref. R311 Vehicle Corrosion Testing Current Design Practice	2	24	[11.9.3.1] None at this time					
				YS	[11.9.4] Oxidation due to Excessive Heat.	4	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. R311 Vehicle Corrosion Testing Material Specs. Current Design Practice	3	72	[11.9.4.1]	Larger cooler and in fan air stream.	6	2	3	36
[12] Meet Noise requirements (decibal).	[12.1] Does not meet / Intermittently meets program targets.	Customer dissatisfaction. Moan. Whine. Grunt. Hiss. Whistle. Clonk. Knock. Rattle. Zip. Squeal. Squeak. Rattle in Engine Compartment. Grinding. Miscellaneous Noises.	6	YS	[12.1.1] Excessive pressure pulses from pump causing Moan.	5	Component DVP&R Component FMEA - Ref. R318/R360 Vehicle Durability Cold Start Lab Testing Cold Start Vehicle Testing Lab Durability Testing NVH Veh. Dev. Testing	3	90	[12.1.1.1] None at this time					
				YS	[12.1.2] Insufficient attenuation in the Hydraulic Distribution System causing Moan.	6	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Impulse Testing Cold Room Testing NVH Veh. Dev. Testing	3	108	[12.1.2.1] None at this time					
				YS	[12.1.3] Mis-routed P/S lines causing Moan.	4	WCR Clearance VSA Studies Design Aid Buck Clearance Studies R318/R360 Vehicle Durability	3	72	[12.1.3.1] None at this time					

			Tolerence Stack-up				
YS	[12.1.4] Air leak into system.	5	Steering SDS Evac. & Fill Component DVP&R Component FMEA - Ref. NVH Veh. Dev. Testing	3	90	[12.1.4.1] None at this time	
YS	[12.1.5] Air not removed or added by Reservoir.	5	Steering SDS Evac. & Fill Component DVP&R Component FMEA - Ref. NVH Veh. Dev. Testing	3	90	[12.1.5.1] None at this time	
YS	[12.1.6] Gear Traps Air.	5	Steering SDS Evac. & Fill Component DVP&R Component FMEA - Ref. NVH Veh. Dev. Testing	3	90	[12.1.6.1] None at this time	
YS	[12.1.7] Fluid Cavitation causing Moan.	5	Steering SDS Power Steering Fluid Spec. Evac. & Fill Component DVP&R Component FMEA - Ref. Power Steering Contamination Spec. NVH Veh. Dev. Testing	3	90	[12.1.7.1] None at this time	
	[12.1.8] Thermal Stress of P/S fluid causing Moan.	3	Vehicle Development Testing Steering SDS Power Steering Fluid Spec. Evac. & Fill Component DVP&R Component FMEA - Ref. Power Steering Contamination Spec. NVH Veh. Dev. Testing	3	54	[12.1.8.1] None at this time	
	[12.1.9] Improper fluid type causing Moan.	3	Vehicle Development Testing Steering SDS Power Steering Fluid Spec. Evac. & Fill Component DVP&R Component FMEA - Ref. Power Steering Contamination Spec. NVH Veh. Dev. Testing	3	54	[12.1.9.1] None at this time	
	[12.1.10] Hose contact with adjacent components causing Moan.	3	WCR Clearance VSA Studies Design Aid Buck Clearance Studies R318/R360 Vehicle Durability Tolerence Stack-up	3	54	[12.1.10.1] None at this time	
	[12.1.11] Inadequate Isolation causing Moan.	3	Vehicle Development Testing	3	54	[12.1.11.1] None at this time	

			NVH Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Road Load testing Design Aid Buck WCR Clearance CAD Checks			
	[12.1.12] Natural frequency & Isolation of pump mounting causing Moan.	3	Vehicle Development Testing NVH Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Road Load testing Design Aid Buck WCR Clearance CAD Checks	3	54	[12.1.12.1] None at this time
YS	[12.1.13] Natural frequency & Isolation of Hydraulic Distribution System Brackets causing Moan.	4	Vehicle Development Testing NVH Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Road Load testing Design Aid Buck WCR Clearance CAD Checks	3	72	[12.1.13.1] None at this time
	[12.1.14] Inadequate Isolation of Gear mounting causing Moan.	3	Vehicle Development Testing NVH Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Road Load testing Design Aid Buck WCR Clearance CAD Checks	3	54	[12.1.14.1] None at this time
YS	[12.1.15] Intrained air in the fluid causing Moan.	5	Steering SDS Power Steering Fluid Spec. Evac. & Fill Component DVP&R Component FMEA - Ref. Cold Weather Vehicle Testing	3	90	[12.1.15.1] None at this time
YS	[12.1.16] Order alignment strategy causing Moan.	4	Steering SDS R318/R360 Vehicle Durability Current Design Practice Component DVP&R Material Specs.	3	72	[12.1.16.1] None at this time
	[12.1.17] Improper Pulley ratio causing Moan.	3	Steering SDS R318/R360 Vehicle Durability Current Design Practice Component DVP&R Material Specs.	3	54	[12.1.17.1] None at this time

	[12.1.18] Isolation of the engine mount causing Moan.	3	Vehicle Development Testing NVH Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Road Load testing Design Aid Buck WCR Clearance CAD Checks	4	72	[12.1.18.1] None at this time
YS	[12.1.19] High viscosity of the P/S fluid at very low temperatures causing Whine.	5	Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Cold Room Vehicle Testing Evac. & Fill	2	60	[12.1.19.1] None at this time
YS	[12.1.20] Not enough sound insulation causing Whine.	4	Vehicle Development Testing NVH Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Road Load testing Design Aid Buck WCR Clearance CAD Checks	2	48	[12.1.20.1] None at this time
YS	[12.1.21] Low P/S fluid level causing Whine.	5	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Cold Room Testing Tolerence Studies Power Steering Contamination Spec. Constant Tension Clamp Spec. Full Lock System Integrity Evac. & Fill	2	60	[12.1.21.1] None at this time
YS	[12.1.22] Fluid cavitation causing Whine.	4	Steering SDS Power Steering Fluid Spec. Evac. & Fill Component DVP&R Component FMEA - Ref. Power Steering Contamination Spec. NVH Veh. Dev. Testing	3	72	[12.1.22.1] None at this time
	[12.1.23] Improper P/S fluid causing Whine.	3	Steering SDS Power Steering Fluid Spec. Evac. & Fill Component DVP&R Component FMEA - Ref. Power Steering Contamination Spec. NVH Veh. Dev. Testing	3	54	[12.1.23.1] None at this time
	[12.1.24] Over-heated fluid due to hydraulic	3	R318/R360 Vehicle Durability	3	54	[12.1.24.1] None at this time

	breakdown causing Whine.		Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Impulse Testing Cold Room Testing TASE Veh. Dev. Testing			
YS	[12.1.25] Fluid Contamination causing Whine.	6	Power Steering Contamination Spec. Vehicle Development Testing R318/R360 Vehicle Durability Efforts Test Component FMEA - Ref.	4	144	[12.1.25.1] None at this time
YS	[12.1.26] Intrained air in the fluid causing Whine.	6	Steering SDS Power Steering Fluid Spec. Evac. & Fill Component DVP&R Component FMEA - Ref. Cold Weather Vehicle Testing	3	108	[12.1.26.1] None at this time
	[12.1.27] Natural frequency of the pump mounting causing Whine.	3	NVH Vehicle Development Testing R318/R360 Vehicle Durability CAE Analysis Steering SDS Isolator Tuning Nibble Sensitivity Tuning	4	72	[12.1.27.1] None at this time
	[12.1.28] Pump design causing Whine.	2	Component DVP&R Component FMEA - Ref. R318/R360 Vehicle Durability Cold Start Lab Testing Cold Start Vehicle Testing Lab Durability Testing	3	36	[12.1.28.1] None at this time
	[12.1.29] Order alignment strategy causing Whine.	3	Steering SDS R318/R360 Vehicle Durability Current Design Practice Component DVP&R Material Specs.	3	54	[12.1.29.1] None at this time
	[12.1.30] Improper Pulley ratio causing Whine.	2	Steering SDS R318/R360 Vehicle Durability Current Design Practice Component DVP&R Material Specs.	2	24	[12.1.30.1] None at this time
	[12.1.31] Pump location causing Whine.	3	WCR Clearance VSA Studies Design Aid Buck Clearance Studies R318/R360 Vehicle Durability	2	36	[12.1.31.1] None at this time

			Tolerence Stack-up				
	[12.1.32] Too steep of boost curve (pressure vs valve action) causing Grunt.	2	Lab Functional Testing Cold Start Lab Testing Cold Start Vehicle Testing Component DVP&R Component FMEA - Ref. Steering SDS Catch-up Test	2	24	[12.1.32.1] None at this time
YS	[12.1.33] Fluid cavitation causing Grunt.	5	Steering SDS Power Steering Fluid Spec. Evac. & Fill Component DVP&R Component FMEA - Ref. Power Steering Contamination Spec. NVH Veh. Dev. Testing	3	90	[12.1.33.1] None at this time
	[12.1.34] Incorrect valve design causing Grunt, Hiss or Whistle.	2	Component DVP&R Component FMEA - Ref. Vehicle Development Testing Steering SDS	4	48	[12.1.34.1] None at this time
	[12.1.35] High pump flow causing Grunt.	2	Vehicle Development Testing R318/R360 Vehicle Durability Catch-up Test Pump Sizing Calculation Component DVP&R Component FMEA - Ref. Steering SDS Cold Weather Vehicle Testing	3	36	[12.1.35.1] None at this time
YS	[12.1.36] Intrained air causing Grunt.	5	Steering SDS Power Steering Fluid Spec. Evac. & Fill Component DVP&R Component FMEA - Ref. Cold Weather Vehicle Testing	2	60	[12.1.36.1] None at this time
	[12.1.37] Low friction between Gear & valve causing Grunt.	3	Lab Functional Testing Component DVP&R Vehicle Development Testing Steering SDS	3	54	[12.1.37.1] None at this time
	[12.1.38] High front end weight causing Grunt.	2	Vehicle Development Testing Current Design Practice CAE Analysis VSA Studies Road Load Test Design Aid Buck	4	48	[12.1.38.1] None at this time
YS	[12.1.39] System Back pressure causing Grunt.	4	R318/R360 Vehicle Durability	2	48	[12.1.39.1] None at this time

			Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Impulse Testing Cold Room Testing			
	[12.1.40] Steering geometry / Tire Properties causing Grunt, Shudder	2	Vehicle Development Testing Current Design Practice CAE Analysis VSA Studies Road Load Test Design Aid Buck	4	48	[12.1.40.1] None at this time
	[12.1.41] Engine Idle Speed Change Causing Grunt	3	Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Cold Weather Vehicle Testing	2	36	[12.1.41.1] None at this time
YS	[12.1.42] Inadequate hose tuning causing Grunt.	5	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Impulse Testing Cold Room Testing NVH Veh. Dev. Testing	3	90	[12.1.42.1] None at this time
YS	[12.1.43] High viscosity of P/S fluid at very low temp causing Hiss.	5	Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Cold Room Vehicle Testing Evac. & Fill	2	60	[12.1.43.1] None at this time
	[12.1.44] Inadequate isolation in the steering column boot causing Hiss.	3	NVH Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Nibble Sensitivity Study Component DVP&R Road Load Vehicle Isolator Tuning CAE Analysis Modal Analysis Bed Plate Testing	2	36	[12.1.44.1] None at this time
	[12.1.45] High pump flow causing Hiss.	2	NVH Veh. Dev. Testing R318/R360 Vehicle Durability Catch-up Test Pump Sizing Calculation Component DVP&R Component FMEA - Ref.	2	24	[12.1.45.1] None at this time

			Steering SDS Cold Weather Vehicle Testing				
	[12.1.46] Low return line Back pressure causing Hiss.	3	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Impulse Testing Cold Room Testing	2	36	[12.1.46.1] None at this time	
	[12.1.47] Incorrect valve design causing Hiss.	2	Component DVP&R Component FMEA - Ref. Vehicle Development Testing Steering SDS	3	36	[12.1.47.1] None at this time	
YS	[12.1.48] Hydraulic Distribution system design causing Hiss.	4	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Impulse Testing Cold Room Testing	3	72	[12.1.48.1] None at this time	
YS	[12.1.49] Excessive restriction in Hydraulic line causing Whistle.	4	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Impulse Testing Cold Room Testing	2	48	[12.1.49.1] None at this time	
	[12.1.50] Relief valve design causing Whistle.	2	Component DVP&R Component FMEA - Ref. R318/R360 Vehicle Durability Cold Start Lab Testing Cold Start Vehicle Testing Lab Durability Testing	3	36	[12.1.50.1] None at this time	
	[12.1.51] Steep boost curve causing Clonk.	2	Component DVP&R Component FMEA - Ref. Vehicle Development Testing Steering SDS	2	24	[12.1.51.1] None at this time	
	[12.1.52] High assist gain causing Clonk.	3	Lab Functional Testing Cold Start Lab Testing Cold Start Vehicle Testing Component DVP&R Component FMEA - Ref. Steering SDS Catch-up Test	3	54	[12.1.52.1] None at this time	

	[12.1.53] Too small or too stiff Hydraulic distribution lines causing Clonk.	3	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Impulse Testing Cold Room Testing NVH Veh. Dev. Testing	3	54	[12.1.53.1] None at this time
	[12.1.54] High pump flow causing Clonk.	3	Vehicle Development Testing R318/R360 Vehicle Durability Catch-up Test Pump Sizing Calculation Component DVP&R Component FMEA - Ref. Steering SDS Cold Weather Vehicle Testing	2	36	[12.1.54.1] None at this time
	[12.1.55] Loose components in Column assembly causing Knock.	2	Joint Analysis Torque / Angle Test Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS	3	36	[12.1.55.1] None at this time
	[12.1.56] Play / Lash in Column assembly causing Knock.	3	Joint Analysis Torque / Angle Test Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS	3	54	[12.1.56.1] None at this time
	[12.1.57] Excessive play in Steering Column causing Rattle.	3	Joint Analysis Torque / Angle Test Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS	3	54	[12.1.57.1] None at this time
	[12.1.58] Loose components in Steering Column causing Rattle.	3	Joint Analysis Torque / Angle Test Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS	3	54	[12.1.58.1] None at this time
	[12.1.59] "Bonus" parts in Steering Column causing Rattle.	2	Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Vehicle Corrosion Testing Clearance Check Design Aid Buck	7	84	[12.1.59.1] None at this time
YS	[12.1.60] High viscosity of P/S fluid at low temperatures causing Zip Noise.	5	Component DVP&R Component FMEA - Ref. Power Steering Fluid	2	60	[12.1.60.1] None at this time

			Spec. Material Testing Cold Room Vehicle Testing Evac. & Fill			
	[12.1.61] Reservoir position relative to the pump causing Zip Noise.	3	Vehicle Development Testing NVH Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Road Load testing Design Aid Buck WCR Clearance CAD Checks	2	36	[12.1.61.1] None at this time
	[12.1.62] Suction Hose length & diameter causing Zip Noise.	3	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Impulse Testing Cold Room Testing NVH Veh. Dev. Testing	2	36	[12.1.62.1] None at this time
YS	[12.1.63] Fluid Cavitation causing Zip Noise.	5	NVH Veh. Dev. Testing Steering SDS Power Steering Fluid Spec. Evac. & Fill Component DVP&R Component FMEA - Ref. Power Steering Contamination Spec.	3	90	[12.1.63.1] None at this time
	[12.1.64] FEAD belt tension causing Squeal Noise.	3	Steering SDS R318/R360 Vehicle Durability Current Design Practice Component DVP&R Material Specs.	2	36	[12.1.64.1] None at this time
	[12.1.65] FEAD belt misalignment causing Squeal Noise.	3	Steering SDS R318/R360 Vehicle Durability Current Design Practice Component DVP&R	3	54	[12.1.65.1] None at this time
	[12.1.66] Inadequate Rap angle causing Squeal Noise.	2	Steering SDS R318/R360 Vehicle Durability Current Design Practice Component DVP&R Material Specs.	3	36	[12.1.66.1] None at this time
	[12.1.67] Lack of splash protection causing Squeal Noise.	3	Component DVP&R Component FMEA - Ref. R318/R360 Vehicle Durability Cold Temp. Lab Testing Cold Temp. Vehicle Testing	3	54	[12.1.67.1] None at this time

			Lab Durability Testing				
YS	[12.1.68] High P/S fluid viscosity at low temperatures causing Squeal Noise.	5	Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Cold Room Vehicle Testing Evac. & Fill	2	60	[12.1.68.1] None at this time	
	[12.1.69] Instrument panel contact with shroud causing Squeak.	2	WCR Clearance VSA Studies Design Aid Buck Clearance Studies R318/R360 Vehicle Durability Tolerence Stack-up	2	24	[12.1.69.1] None at this time	
	[12.1.70] Improper attachment of the shroud causing Squeak.	2	WCR Clearance VSA Studies Design Aid Buck Clearance Studies R318/R360 Vehicle Durability Tolerence Stack-up	2	24	[12.1.70.1] None at this time	
	[12.1.71] Insufficient Grease on Steering stops causing Squeak.	3	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref.	3	54	[12.1.71.1] None at this time	
	[12.1.72] Inadequate Grease on Steering Ball-joints causing Squeak.	3	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref.	4	72	[12.1.72.1] None at this time	
	[12.1.73] Inadequate clockspring clearance or lubrication causing Squeak.	3	WCR Clearance VSA Studies Design Aid Buck Clearance Studies R318/R360 Vehicle Durability Tolerence Stack-up Component DVP&R Component FMEA - Ref.	4	72	[12.1.73.1] None at this time	
	[12.1.74] Inadequate Column clearance or Grease causing Squeak.	2	WCR Clearance VSA Studies Design Aid Buck Clearance Studies R318/R360 Vehicle Durability Tolerence Stack-up Component DVP&R Component FMEA - Ref.	4	48	[12.1.74.1] None at this time	
	[12.1.75] P/S lines misrouted causing Rattle in Engine Compartment.	3	WCR Clearance VSA Studies Design Aid Buck Clearance Studies R318/R360 Vehicle Durability Tolerence Stack-up	3	54	[12.1.75.1] None at this time	
	[12.1.76] Heat shield / Heat shield bracket loose causing Rattle in Engine	3	R318/R360 Vehicle Durability Component DVP&R	3	54	[12.1.76.1] None at this time	

Compartment.		Component FMEA - Ref. R311 Vehicle Corrosion Testing Vibration Testing - Road Load Data Steering SDS			
[12.1.77] Steering wheel to shroud interference causing Grinding Noise.	2	WCR Clearance VSA Studies Design Aid Buck Clearance Studies R318/R360 Vehicle Durability Tolerence Stack-up	3	36	[12.1.77.1] None at this time
[12.1.78] Bearing contaminated / deformed / mis-assembled causing Grinding Noise.	2	Vehicle Development Testing R318/R360 Vehicle Durability Efforts Test Component FMEA - Ref.	6	72	[12.1.78.1] None at this time
[12.1.79] Foreign material in contact with shaft causing Grinding Noise.	2	Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Vehicle Corrosion Testing Clearance Check Design Aid Buck	7	84	[12.1.79.1] None at this time
[12.1.80] Clock spring off-center causing Grinding Noise.	2	WCR Clearance VSA Studies Design Aid Buck Clearance Studies R318/R360 Vehicle Durability Tolerence Stack-up	3	36	[12.1.80.1] None at this time
[12.1.81] Boot interference to I-shaft.	2	WCR Clearance VSA Studies Design Aid Buck Clearance Studies R318/R360 Vehicle Durability Tolerence Stack-up	3	36	[12.1.81.1] None at this time
[12.1.82] Loose Gear attachment.	2	Fatigue Test Max. Input Torque Brinell Test Impact Test Gear Attachment Testing Efforts Test	3	36	[12.1.82.1] None at this time
[12.1.83] Outer Tie rods loose.	3	Vehicle Development Testing Component DVP&R Component FMEA - Ref. Steering SDS Efforts Test	3	54	[12.1.83.1] None at this time
[12.1.84] Clicking / Racheting noise due to improper centering of Clock spring.	2	WCR Clearance VSA Studies Design Aid Buck Clearance Studies R318/R360 Vehicle	3	36	[12.1.84.1] None at this time

							Durability Tolerence Stack-up				
[13] Meet Vibration requirements (frequency).	[13.1] Does not meet / Intermittently meets program targets.	Customer dissatisfaction. Shudder. Column / Steering Wheel Shake. Buzz / Grungy. Wheel Fight. Nibble. Misc. small vibration in Steering Wheel.	6		[13.1.1] Improper Hydraulic Distribution system Tuning causing Shudder.	3	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Impulse Testing Cold Room Testing NVH Veh. Dev. Testing	3	54	[13.1.1.1] None at this time	
					[13.1.2] Excessive Steering / Suspension feedback forces causing Shudder.	3	Vehicle Development Testing NVH Vehicle Development Testing R318/R360 Vehicle Durability CAE Analysis Road Load testing Isolator Tuning Nibble Sensitivity Tuning Steering SDS	4	72	[13.1.2.1] None at this time	
				YS	[13.1.3] Intrained air causing Shudder.	4	Steering SDS Power Steering Fluid Spec. Evac. & Fill Component DVP&R Component FMEA - Ref. Cold Weather Vehicle Testing	3	72	[13.1.3.1] None at this time	
					[13.1.4] Too steep of a boost curve causing Shudder.	2	Component DVP&R Component FMEA - Ref. Vehicle Development Testing Steering SDS	3	36	[13.1.4.1] None at this time	
					[13.1.5] High pump flow causing Shudder.	2	Vehicle Development Testing R318/R360 Vehicle Durability Catch-up Test Pump Sizing Calculation Component DVP&R Component FMEA - Ref. Steering SDS Cold Weather Vehicle Testing	2	24	[13.1.5.1] None at this time	
					[13.1.6] Low friction / Lack of adequate damping causing Shudder.	3	Lab Functional Testing Component DVP&R Vehicle Development Testing Steering SDS	3	54	[13.1.6.1] None at this time	
					[13.1.7] High front end weight causing Shudder.	2	Vehicle Development Testing Current Design Practice CAE Analysis VSA Studies Road Load Test	4	48	[13.1.7.1] None at this time	

			Design Aid Buck				
YS	[13.1.8] System Back pressure causing Shudder.	4	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Impulse Testing Cold Room Testing	2	48	[13.1.8.1] None at this time
	[13.1.9] Improper Mode alignment strategy causing Column / Steering Wheel Shake (Column - Engine).	3	NVH Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Nibble Sensitivity Study Component DVP&R Road Load Vehicle Isolator Tuning CAE Analysis Modal Analysis Bed Plate Testing	3	54	[13.1.9.1] None at this time
	[13.1.10] Column natural frequency too low causing Column / Steering Wheel Shake.	3	NVH Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Nibble Sensitivity Study Component DVP&R Road Load Vehicle Isolator Tuning CAE Analysis Modal Analysis Bed Plate Testing	4	72	[13.1.10.1] None at this time
	[13.1.11] Pulley ratio causing Buzz / Grungy.	2	Steering SDS R318/R360 Vehicle Durability Current Design Practice Component DVP&R Material Specs.	2	24	[13.1.11.1] None at this time
	[13.1.12] Large forcing function - Engine torque pulses causing Buzz / Grungy.	3	NVH Vehicle Development Testing R318/R360 Vehicle Durability CAE Analysis Steering SDS Isolator Tuning Nibble Sensitivity Tuning	4	72	[13.1.12.1] None at this time
	[13.1.13] Improper Hydraulic Distribution system Tuning causing Buzz / Grungy.	3	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Impulse Testing Cold Room Testing NVH Veh. Dev. Testing	3	54	[13.1.13.1] None at this time
YS	[13.1.14] Excessive pump	4	NVH Vehicle	2	48	[13.1.14.1] None at this

pressure pulses causing Buzz / Grungy.		Development Testing R318/R360 Vehicle Durability CAE Analysis Steering SDS Isolator Tuning Nibble Sensitivity Tuning			time
[13.1.15] Inadequate system friction causing Buzz / Grungy.	3	Vehicle Development Testing NVH Vehicle Development Testing R318/R360 Vehicle Durability CAE Analysis Road Load testing Isolator Tuning Nibble Sensitivity Tuning Steering SDS	3	54	[13.1.15.1] None at this time
[13.1.16] Natural frequency of Gear valve / Steering Wheel aligned with pump pulses causing Buzz / Grungy.	3	Component DVP&R Component FMEA - Ref. Steering SDS NVH Veh. Dev. Testing	3	54	[13.1.16.1] None at this time
[13.1.17] Inadequate Column Isolation causing Buzz / Grungy.	3	NVH Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Nibble Sensitivity Study Component DVP&R Road Load Vehicle Isolator Tuning CAE Analysis Modal Analysis Bed Plate Testing	2	36	[13.1.17.1] None at this time
[13.1.18] Inadequate system friction causing Wheel fight.	3	Vehicle Development Testing NVH Vehicle Development Testing R318/R360 Vehicle Durability CAE Analysis Road Load testing Isolator Tuning Nibble Sensitivity Tuning	3	54	[13.1.18.1] None at this time
[13.1.19] Steering / Suspension geometry causing Wheel fight.	3	Vehicle Development Testing Current Design Practice CAE Analysis VSA Studies Road Load Test Design Aid Buck	4	72	[13.1.19.1] None at this time
[13.1.20] Excessive driving force from Tires / Wheel causing Nibble.	3	Vehicle Development Testing Alignment Studies Road Load testing Pilot Build	5	90	[13.1.20.1] None at this time
[13.1.21] Inadequate Gear interaction causing Nibble.	3	Fatigue Test Max. Input Torque Brinell Test Impact Test	4	72	[13.1.21.1] None at this time

							Gear Attachment Testing Efforts Test				
					[13.1.22] Inadequate Column damping causing Nibble.	3	NVH Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Nibble Sensitivity Study Component DVP&R Road Load Vehicle Isolator Tuning CAE Analysis Modal Analysis Bed Plate Testing	3	54	[13.1.22.1] None at this time
					[13.1.23] Steering / Suspension geometry causing Nibble.	2	Vehicle Development Testing Current Design Practice CAE Analysis VSA Studies Road Load Test Design Aid Buck	4	48	[13.1.23.1] None at this time
					[13.1.24] Outside influences like Tire imbalance, Brake roughness, Alignment& Engine roughness causing Nibble.	3	Vehicle Development Testing Alignment Studies Road Load testing Pilot Build	5	90	[13.1.24.1] None at this time
[14] Steering Brackets: Provide accessory support, alignment & NVH isolation.	[14.1] Bracket / Mount failure (Breaks / Cracks).	May not meet FMVSS 208. Excessive Noise & / or Vibration. Possibility / Accelaration of component detaching itself from the assembly. Can cause structural resonance. Can fracture additional brackets / mounts. Can cause pressure ripples in the Hydraulic system leading to Noise. Degraded vehicle directional control.	10	YC	[14.1.1] corrosion.	4	Component DVP&R Component FMEA - Ref. R311 Vehicle Corrosion Testing Current Design Practice	2	80	[14.1.1.1] None at this time
				YC	[14.1.2] Improper torque spec.	3	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. R311 Vehicle Corrosion Testing Vibration Testing - Road Load Data Steering SDS	2	60	[14.1.2.1] None at this time
				YC	[14.1.3] Hydrogen embrittlement.	3	Component DVP&R Component FMEA - Ref. R311 Vehicle Corrosion Testing Current Design Practice	3	90	[14.1.3.1] None at this time
				YC	[14.1.4] Grounding switches to column.	2	WCR Clearance VSA Studies Design Aid Buck Clearance Studies R318/R360 Vehicle Durability Tolerence Stack-up	3	60	[14.1.4.1] None at this time
	[14.2] Does not hold the component in place.	Noise. Customer dissatisfaction.	10	YC	[14.2.1] Inadequate bolt tension.	4	Vehicle Development Testing NVH Vehicle	2	80	[14.2.1.1] None at this time

	May not meet FMVSS 203 or 208.					Development Testing R318/R360 Vehicle Durability Steering SDS Road Load testing Design Aid Buck WCR Clearance CAD Checks				
			YC	[14.2.2] Crash shear mechanism not strong enough.	2	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. R311 Vehicle Corrosion Testing Vibration Testing - Road Load Data Steering SDS Vehicle Crash Test	6	120	[14.2.2.1] None at this time	
			YC	[14.2.3] Improper stack-up.	3	Vehicle Development Testing NVH Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Road Load testing Design Aid Buck WCR Clearance CAD Checks	3	90	[14.2.3.1] None at this time	
			YC	[14.2.4] Failure of mounting plate.	3	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. R311 Vehicle Corrosion Testing Vibration Testing - Road Load Data Steering SDS	4	120	[14.2.4.1] None at this time	
[14.3] Mis-alignment.	Can affect Gear function. Can affect Suspension geometry parameters. Can fracture the mating surface. Customer dissatisfaction. Can impair vision of cluster. Squeaks.	6		[14.3.1] Mounts out of alignment linearily & / or angularily.	3	Vehicle Development Testing NVH Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Road Load testing Design Aid Buck WCR Clearance CAD Checks	4	72	[14.3.1.1] None at this time	
				[14.3.2] Failure of the mounting plate.	3	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. R311 Vehicle Corrosion Testing Vibration Testing - Road Load Data Steering SDS	4	72	[14.3.2.1] None at this time	
				[14.3.3] Improper stack-up.	3	Vehicle Development Testing NVH Vehicle Development Testing R318/R360 Vehicle	3	54	[14.3.3.1] None at this time	

							Durability Steering SDS Road Load testing Design Aid Buck WCR Clearance CAD Checks			
	[14.4] Insufficient or inadequate isolation.	Excessive Noise & Vibration. Does not isolate Road Noise. Customer dissatisfaction. Can cause structural resonance.	6	YS	[14.4.1] Improper Isolation Material.	4	NVH Vehicle Development Testing. CAE Analysis. Isolator Tuning. Nibble Sensitivity Tuning. Steering SDS. R318/R360 Vehicle Durability.	2	48	[14.4.1.1] None at this time
					[14.4.2] Improper Bolt Tension.	3	NVH Vehicle Development Testing. CAE Analysis. Isolator Tuning. Nibble Sensitivity Tuning. Steering SDS. R318/R360 Vehicle Durability.	3	54	[14.4.2.1]
					[14.4.3] Too small an Isolator.	3	NVH Vehicle Development Testing. CAE Analysis. Isolator Tuning. Nibble Sensitivity Tuning. Steering SDS. R318/R360 Vehicle Durability.	2	36	[14.4.3.1]
	[14.5] Too much isolation.	Allows too much compliance. May not transmit positive road feel to the driver.	6		[14.5.1] Too Thick an Isolator.	2	NVH Vehicle Development Testing. CAE Analysis. Isolator Tuning. Nibble Sensitivity Tuning. Steering SDS. R318/R360 Vehicle Durability.	3	36	[14.5.1.1] None at this time
[15] Fluid conditioning.	[15.1] Does not contain particulate contamination.	Contaminated Fluid. Pump Breakdown. Gear Breakdown. Zero Power Assist. Intermittent Loss of Power Assist. Excessive Noise. Reduced life of system.	7	YS	[15.1.1] High Pressure Drop across the Filter due to Filter Clog-up / High viscosity at low temperature.	4	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Impulse Testing Cold Room Testing	5	140	[15.1.1.1] None at this time
				YS	[15.1.2] Screen Tear in the Reservoir due to High Suction Force.	4	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Impulse Testing Cold Room Testing	5	140	[15.1.2.1] None at this time
				YS	[15.1.3] External contamination ingression.	4	Power Steering Contamination Spec. Vehicle Development Testing R318/R360 Vehicle Durability Efforts Test	5	140	[15.1.3.1] None at this time

						Component FMEA - Ref.				
[15.2] Does not Cool Fluid to meet WCR Standards.	Fluid Breakdown. Pump damage. Hose material damage. Gear damage. System noise.	7		[15.2.1] Additive Breakdown in the Fluid.	2	TASE Vehicle Development Testing Steering SDS Power Steering Fluid Spec. Evac. & Fill Component DVP&R Component FMEA - Ref. Power Steering Contamination Spec.	7	98	[15.2.1.1] None at this time	
			YS	[15.2.2] Contamination of the Fluid.	4	Power Steering Contamination Spec. Vehicle Development Testing R318/R360 Vehicle Durability Efforts Test Component FMEA - Ref.	5	140	[15.2.2.1] None at this time	
			YS	[15.2.3] Radiant Heat in the Underhood environment.	5	WCR Clearance VSA Studies Design Aid Buck Clearance Studies R318/R360 Vehicle Durability Tolerence Stack-up	3	105	[15.2.3.1] None at this time	
			YS	[15.2.4] Inadequate cooling.	5	WCR Clearance VSA Studies Design Aid Buck Clearance Studies R318/R360 Vehicle Durability Tolerence Stack-up	2	70	[15.2.4.1] None at this time	
[15.3] Over Cools Fluid.	Increased pump load on engine. Might not meet CAFE requirements.	6		[15.3.1] Heat loss from the underhood environment.	3	WCR Clearance VSA Studies Design Aid Buck Clearance Studies R318/R360 Vehicle Durability Tolerence Stack-up	3	54	[15.3.1.1] None at this time	
				[15.3.2] Packaging deficiency.	3	WCR Clearance VSA Studies Design Aid Buck Clearance Studies R318/R360 Vehicle Durability Tolerence Stack-up	2	36	[15.3.2.1] None at this time	
[15.4] Allows aeration.	Fluid breakdown. System noise & vibration. Pump damage.	6		[15.4.1] Damage / wear of the Gear system.	3	VE5C3C-3504-AA Section III.J-Block Cycle Fatigue (Visteon Gear DVP) VE5C3C-3504-AA Section III.H-Gear Impact (Visteon Gear DVP) VE5C3C-3504-AA Section III.C-Sector Torque Cycling (Visteon Gear DVP) R318/R360 Vehicle Durability Gear Attachment	2	36	[15.4.1.1] None at this time	

								Testing Efforts Test See Gear FMEA			
					[15.4.2] Damage / wear of the pump system.	3		See Pump DVP&R See Pump FMEA R318/R360 Vehicle Durability Cold Start Lab Testing Cold Start Vehicle Testing Lab Durability Testing	2	36	[15.4.2.1] None at this time
					[15.4.3] Damage / wear of the Distribution system.	3		R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Impulse Testing Cold Room Testing	3	54	[15.4.3.1] None at this time
[16] Provide Power Assist to Hydroboost	[16.1] Does not provide Power Assist to Hydroboost	Very High Braking Effort. Very High Steering Effort. Customer Dissatisfaction.	9	YC	[16.1.1] Damage / wear of the pump system.	3		See Pump DVP&R See Pump FMEA R318/R360 Vehicle Durability Cold Start Lab Testing Cold Start Vehicle Testing Lab Durability Testing	3	81	[16.1.1.1] None at this time
				YC	[16.1.2] Damage / wear of the Distribution system.	3		R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Impulse Testing Cold Room Testing	3	81	[16.1.2.1] None at this time
				YC	[16.1.3] Damage / wear of the Hydroboost.	4		Component DVP&R Component FMEA - Ref. R318/R360 Vehicle Durability Cold Start Lab Testing Cold Start Vehicle Testing Lab Durability Testing	3	108	[16.1.3.1] None at this time
				YC	[16.1.4] Excessive Contamination in the Hydraulic Distribution System.	4		Power Steering Contamination Spec. R318/R360 Vehicle Durability Power Steering Fluid Spec.	6	216	[16.1.4.1] None at this time
	[16.2] Provides Partial Assist	High Braking Effort. High Steering Effort. Customer Dissatisfaction.	7		[16.2.1] Damage / wear of the pump system.	3		See Pump DVP&R See Pump FMEA R318/R360 Vehicle Durability Cold Start Lab Testing Cold Start Vehicle Testing Lab Durability Testing	3	63	[16.2.1.1] None at this time
				YS	[16.2.2] Damage / wear of the Distribution system.	4		R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Power Steering Fluid	3	84	[16.2.2.1] None at this time

						Spec. Material Testing Impulse Testing Cold Room Testing				
				[16.2.3] Damage / wear of the Hydroboost.	3	Component DVP&R Component FMEA - Ref. R318/R360 Vehicle Durability Cold Start Lab Testing Cold Start Vehicle Testing Lab Durability Testing	3	63	[16.2.3.1] None at this time
			YS	[16.2.4] Excessive Contamination in the Hydraulic Distribution System.	5	Power Steering Contamination Spec. R318/R360 Vehicle Durability Power Steering Fluid Spec.	4	140	[16.2.4.1] None at this time
[16.3] Intermittent / Erratic Assist	Erratic Braking Effort. Erratic Steering Effort / response. Customer Dissatisfaction.	8		[16.3.1] Damage / wear of the pump system.	3	See Pump DVP&R See Pump FMEA R318/R360 Vehicle Durability Cold Start Lab Testing Cold Start Vehicle Testing Lab Durability Testing	3	72	[16.3.1.1] None at this time
				[16.3.2] Damage / wear of the Distribution system.	3	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec. Material Testing Impulse Testing Cold Room Testing	3	72	[16.3.2.1] None at this time
				[16.3.3] Damage / wear of the Hydroboost.	3	Component DVP&R Component FMEA - Ref. R318/R360 Vehicle Durability Cold Start Lab Testing Cold Start Vehicle Testing Lab Durability Testing	3	72	[16.3.3.1] None at this time
			YS	[16.3.4] Excessive Contamination in the Hydraulic Distribution System.	5	Power Steering Contamination Spec. R318/R360 Vehicle Durability Power Steering Fluid Spec.	4	160	[16.3.4.1] None at this time
[16.4] Does not meet Program targets	High Braking Effort. High Steering Effort. Customer Dissatisfaction.	5		[16.4.1] Damage / wear of the pump system.	3	See Pump DVP&R See Pump FMEA R318/R360 Vehicle Durability Cold Start Lab Testing Cold Start Vehicle Testing Lab Durability Testing	2	30	[16.4.1.1] None at this time
				[16.4.2] Damage / wear of the Distribution system.	3	R318/R360 Vehicle Durability Component DVP&R Component FMEA - Ref. Power Steering Fluid Spec.	3	45	[16.4.2.1] None at this time

							Material Testing Impulse Testing Cold Room Testing				
					[16.4.3] Damage / wear of the Hydroboost.	3	Component DVP&R Component FMEA - Ref. R318/R360 Vehicle Durability Cold Start Lab Testing Cold Start Vehicle Testing Lab Durability Testing	3	45	[16.4.3.1] None at this time
				YS	[16.4.4] Excessive Contamination in the Hydraulic Distribution System.	5	Power Steering Contamination Spec. R318/R360 Vehicle Durability Power Steering Fluid Spec.	4	100	[16.4.4.1] None at this time
[17] Provide mechanism for alignment (Assembly & Serviceability).	[17.1] Not enough adjustment travel.	Excessive tire wear. Customer dissatisfaction. Degraded system performance.	6		[17.1.1] Build variation is too large.	3	Vehicle Development Testing Alignment Studies Road Load testing Pilot Build	5	90	[17.1.1.1] None at this time
	[17.2] Too difficult to adjust.	Assembly plant dissatisfaction. Serviceability concern.	6		[17.2.1] Poor accessability to Tie rod.	3	WCR Clearance VSA Studies Design Aid Buck Clearance Studies Tolerence Stack-up	2	36	[17.2.1.1] None at this time
					[17.2.2] Adjustment efforts too high.	3	WCR Clearance VSA Studies Design Aid Buck Clearance Studies Tolerence Stack-up Steering SDS	3	54	[17.2.2.1] None at this time
	[17.3] Self adjusts (does not maintain) while driving.	Excessive tire wear. Customer dissatisfaction. Degraded system performance.	6		[17.3.1] Inadequate clamping force between Tie rod & Tie rod end under all operating conditions.	3	Vehicle Development Testing NVH Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Road Load testing Design Aid Buck WCR Clearance CAD Checks	4	72	[17.3.1.1] None at this time
					[17.3.2] Suspension / Alignment defect.	3	Vehicle Development Testing NVH Vehicle Development Testing R318/R360 Vehicle Durability CAE Analysis Road Load testing Isolator Tuning Nibble Sensitivity Tuning Steering SDS	5	90	[17.3.2.1] None at this time
[18] Appearance - Must meet program objectives.	[18.1] Does not meet program objectives.	Customer dissatisfaction.	6		[18.1.1] Column mis-alignment to Instrument panel.	3	Vehicle Development Testing NVH Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Road Load testing	3	54	[18.1.1.1] None at this time

							Design Aid Buck WCR Clearance CAD Checks			
					[18.1.2] External non-Column part does not function properly.	2	Component DVP&R Component FMEA - Ref. Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Fatigue Test Ultimate Strength Test Efforts Test	5	60	[18.1.2.1] None at this time
					[18.1.3] Damage while handling.	3	Vehicle Development Testing NVH Vehicle Development Testing R318/R360 Vehicle Durability Steering SDS Road Load testing Design Aid Buck WCR Clearance CAD Checks	3	54	[18.1.3.1] None at this time
[19] Display Power Steering Fluid level in the Reservoir to user.	[19.1] Does not display fluid level.	Difficult to Service. Improper fluid fill.	4		[19.1.1] Distribution system not optimized (packaging, material translucence, user ergonomics)	2	Serviceability Sign-off	2	16	[19.1.1.1] None at this time
[20] Permit Power Steering Fluid addition to the reservoir (B&A and Service).	[20.1] Does not permit or difficult to add fluid at B&A.	Improper Fluid Fill Customer Dissatisfaction Excessive Noise	4		[20.1.1] Improper Distribution System package.	3	Prototype Builds Service Sign-off VO/Supplier system breadboard testing	2	24	[20.1.1.1] None at this time
					[20.1.2] Restrictions in fluid passages of steering system	2	Prototype Builds Service Sign-off VO/Supplier system breadboard testing	2	16	[20.1.2.1]
	[20.2] Does not permit access to Service.	Improper Fluid Fill Customer Dissatisfaction Excessive Noise	4		[20.2.1] Improper Distribution System package.	3	Design Reviews Service Sign-off	2	24	[20.2.1.1] None at this time
[21] Allows repair and replacement without disassembly of other major subsystems without use of special tools (B&A and Service)	[21.1] Does not allow repair and replacement without disassembly of other major subsystems	Longer repair time Higher repair cost Increased warranty cost	5		[21.1.1] Component packaging without adequate attention to service requirements	3	Service Sign-off Prototype Builds	2	30	[21.1.1.1]
	[21.2] Requires special tools for service	Longer repair time Higher repair cost Increased special service tool cost	5		[21.2.1] Component packaging without adequate attention to service requirements	3	Service Sign-off Prototype Builds	2	30	[21.2.1.1]
[22] Permit assembly at production rates (including ergonomics) and service feasibility to SDS and WCR	[22.1] Does not permit assembly at production rates.	No build Reduced line rate	8		[22.1.1] Improper Steering System package design for tool clearance.	2	Tool Clearance Studies Design Aid Buck Pilot Build Component FMEA - Ref.	2	32	[22.1.1.1] None at this time
					[22.1.2] Improper geometry / tolerance on mating surfaces	2	Design Aid Buck Pilot Build Stack-ups Component FMEA - Ref.	2	32	[22.1.2.1] None at this time
	[22.2] Intermittently does not permit assembly at production rates.	Mis-assembly of system System Leaks Excessive Noise B&A Production Loss Impaired vehicle control	9	YC	[22.2.1] Improper Steering System package design (for tool or hand clearance).	2	Tool Clearance Studies Design Aid Buck Pilot Build	2	36	[22.2.1.1] None at this time
				YC	[22.2.2] Improper tolerance on mating surfaces.	3	Design Aid Buck Pilot Build Stack-ups Component FMEA -	2	54	[22.2.2.1] None at this time

						Ref.				
[22.3] Not easy to assemble.	Mis-assembly of system System Leaks Excessive Noise B&A Production Loss Impaired vehicle control Added Assembly cost	9	YC	[22.3.1] Improper Steering System package design (blind assembly)	2	Pilot Build	2	36	[22.3.1.1] None at this time	
[22.4] System not accessible for Service to WCR requirements	Customer dissatisfaction Increased Warranty Costs	5		[22.4.1] Improper Steering System package design (for tool or hand clearance).	3	Tool Clearance Studies Design Aid Buck Pilot Build	2	30	[22.4.1.1] None at this time	

PE07-057

FORD

2-4-2008

APPENDIX K

DFMEA - Monobeam Front Suspension

Ford Motor Company

POTENTIAL FAILURE MODE AND EFFECTS ANALYSIS
- DESIGN FMEA -

_X_ System: 040100 FRONT SUSPENSION SYSTEM, MONOBEAM
___ Subsystem:
___ Component:

Design Responsibility: Suspension Engineering

Key Date:

FMEA Number: DFMEA - Mono

Prepared by: Jerry Nantais / 39-02923 / Tough Tru

Vehicle Program: P131 / 2005
Core Team: C. Hodges J. Nantais H. Hess S. Rollinger P. Trujillo B. Mazany

FMEA Date (Orig.) 19 Mar 2002 (Rev.) 11 Dec 200

Item/Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause/ Mechanism of Failure	Occ	Current Design Controls	Det	RPN	Recommended Action	Responsibility and Target Completion Date	Action Actions Taken	Sev	Occ	Det	RPN
[1] General Requirements for all functions: - 10 yrs, 150K miles customer usage - on/off road usage - Operate in the range of -40°C to +50°C at varying environmental cond tions.	[1.1] Definitions: GAWR = Gross Axle Weight Rating				[1.1.1]					[1.1.1.1]						
[2]	[2.1] {NO FUNCTION}	{PARTS OR SUBCOMPONENTS NEXT HIGHER ASSEMBLY SYSTEM FINAL PRODUCT (VEHICLE) CUSTOMER GOVERNMENT REGULATIONS}			[2.1.1] {1. MANUFACTURING PIECE TO PIECE 2. DETERIORATION OVER TIME / MILEAGE 3. CUSTOMER USAGE / DUTY CYCLE 4. NEIGHBORING SUB-SYSTEMS 5. ENVIRONMENT}					[2.1.1.1]						
	[2.2] {PARTIAL/OVER FUNCTION / DEGRADED OVER TIME}	{PARTS OR SUBCOMPONENTS NEXT HIGHER ASSEMBLY SYSTEM FINAL PRODUCT (VEHICLE) CUSTOMER GOVERNMENT REGULATIONS}			[2 2.1] {1. MANUFACTURING PIECE TO PIECE 2. DETERIORATION OVER TIME / MILEAGE 3. CUSTOMER USAGE / DUTY CYCLE 4. NEIGHBORING SUB-SYSTEMS 5. ENVIRONMENT}					[2 2.1.1]						
	[2.3] {INTERMITTENT FUNCTION}	{PARTS OR SUBCOMPONENTS NEXT HIGHER ASSEMBLY SYSTEM FINAL PRODUCT (VEHICLE) CUSTOMER GOVERNMENT REGULATIONS}			[2.3.1] {1. MANUFACTURING PIECE TO PIECE 2. DETERIORATION OVER TIME / MILEAGE 3. CUSTOMER USAGE / DUTY CYCLE 4. NEIGHBORING SUB-SYSTEMS 5. ENVIRONMENT}					[2.3.1.1]						
	[2.4] {UNINTENDED FUNCTION}	{PARTS OR SUBCOMPONENTS NEXT HIGHER ASSEMBLY SYSTEM FINAL PRODUCT (VEHICLE) CUSTOMER GOVERNMENT REGULATIONS}			[2.4.1] {1. MANUFACTURING PIECE TO PIECE 2. DETERIORATION OVER TIME / MILEAGE 3. CUSTOMER USAGE / DUTY CYCLE 4. NEIGHBORING SUB-SYSTEMS 5. ENVIRONMENT}					[2.4.1.1]						
[3] Maintain desired vehicle attitude and appearance	[3.1] Ground clearance too small / ride height too low by design	- Customer dissatisfaction due to underbody component damage - Customer dissatisfaction with vehicle appearance of forward lean	7		[3.1.1] Incorrect weight or weight distribution assumption	3	- Weight Engineering analysis - Weigh prototype vehicles - Fresh Eyes Reviews	3	63	[3.1.1.1] Get updated weight projections after each prototype build	H. Hess Post AP3/Post CP		5	3	2	30
					[3.1.2] Incorrect spring rate/load specified	2	- Weight Engineering Analysis - Spring load calculations - Ride height measurement on development vehicles - Spring selection chart	3	42	[3.1.2.1] Get updated weight projections after each prototype build	H. Hess Post AP3/Post CP		7	2	2	28
	[3.2] Ground clearance excessive / ride height too high by design	- Customer dissatisfaction due to difficulty with snow plow hook-up - Customer dissatisfaction with vehicle appearance of	7		[3 2.1] Incorrect weight or weight distribution assumption	3	- Weight Engineering analysis - Weigh prototype vehicles - Fresh Eyes Reviews	3	63	[3 2.1.1] Get updated weight projections after each prototype build	H. Hess Post AP3/Post CP		7	3	2	42

Item/Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause/ Mechanism of Failure	Occ	Current Design Controls	Det	RPN	Recommended Action	Responsibility and Target Completion Date	Action Taken	Sev	Occ	Det	RPN
		rearward lean			[3 2.2] Incorrect spr ng rate/load specified	2	- Weight Engineering Analysis - Spring load calculations - Ride height measurement on development vehicles - Spring selection chart	3	42	[3 2.2.1] Get updated we ght projections after each prototype build	H. Hess Post AP3/Post CP		7	2	2	28
	[3.3] Visible red rust on vehicle underside	- Customer dissatisfaction with vehicle appearance	3		[3.3.1] Inadequate corrosion protection specified	3	- Vehicle Corros on test - Component FMEA/DVP&R - Materials sign-off	3	27	[3.3.1.1] Review material selections and finish with Materials CPS	C. Hodges 4/03		3	3	2	18
										[3.3.1 2] Review fastener finish select ons with Fastener CPS	C. Hodges 4/03		3	3	2	18
					[3.3.2] Dissimilar metal interaction / electrolysis	3	- Vehicle Corrosion test - Component FMEA/DVP&R - Materials sign-off	3	27	[3.3.2.1] Review material selections and finish with Materials CPS	C. Hodges 4/03		3	3	2	18
										[3.3.2 2] Review fastener finish selections with Fastener CPS	C. Hodges 4/03		3	3	2	18
					[3.3.3] Customer duty cycle in extreme environmental conditions	2	- Vehicle Corros on test - Component FMEA/DVP&R - Materials sign-off	3	18	[3.3.3.1] Review material selections and finish with Materials CPS	C. Hodges 4/03		3	2	2	12
										[3.3.3 2] Review fastener finish selections with Fastener CPS	C. Hodges 4/03		3	2	2	12
[4] Support sprung mass at the rated GAWR load cond tions at program design height:	[4.1] Does not support sprung mass at maximum loaded condition	- Vehicle operable only to maneuver safely to roadside (7) - Degraded vehicle control (7) - Vehicle cannot support rated load (7) - Degraded ride (6)	7	YS	[4.1.1] Customer loading vehicle beyond design load / duty cycle	10	- Use safety factors in design calculations - Published GAWR and payload ratings in Marketing L terature - GAWR ratings included on Federally regulated Safety Certification Label	1	70	[4.1.1.1] None						
					[4.1.2] Co l spring failure (fracture, yield, corrosion)	2	- Vehicle Durability test - Vehicle Corrosion test - Component FMEA/DVP&R	3	42	[4.1.2.1] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		7	2	2	28
					[4.1.3] Suspension arm fa lure (radius arm, track bar, sta bar, sta bar inks, brackets)	3	- Vehicle Durability test - Vehicle Corrosion test - Component FMEA/DVP&R	3	63	[4.1.3.1] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		7	3	2	42
					[4.1.4] Joint/Fastener failure	2	- Vehicle Durability test - Vehicle Corrosion test - Component FMEA/DVP&R	3	42	[4.1.4.1] Review joint designs with Fastener CPS	C. Hodges 4/03		7	2	2	28
										[4.1.4 2] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		7	2	2	28
	[4.2] Front end too low or too high	- Customer dissatisfied with vehicle appearance (4) - Red. ground clearance (5) - Degraded handling (6) - Tire wear (5) - Red. comp. durab lity (3) - Harsh ride (bottom out)(6) - Wheel fight (5) - Loss of load carrying capability (5)	6	YS	[4 2.1] Customer loaded vehicle beyond design load	10	- Use safety factors in design calculations - Published GAWR and payload ratings in Marketing L terature - GAWR ratings included on Federally regulated Safety Certification Label	1	60	[4 2.1.1] None						
					[4 2.2] Incorrect weight or we ght distribution assumption	3	- Weight Engineering analysis - Weigh prototype vehicles - Fresh Eyes Reviews	3	54	[4 2.2.1] Get updated we ght projections after each prototype build	H. Hess Post AP3/Post CP		7	3	2	42
					[4 2.3] Incorrect spring rate/load specified	2	- Weight Engineering Analysis - Spring load calculations - Ride height measurement on development vehicles - Spring selection chart	3	36	[4 2.3.1] Get updated weight projections after each prototype build	H. Hess Post AP3/Post CP		6	2	2	24
					[4 2.4] Spring sag	3	- Vehicle Durability tests - Vehicle Corrosion test - Component FMEA/DVP&R	3	54	[4 2.4.1] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		6	3	2	36
					[4 2.5] Shock tower or spring seat failure	2	- Vehicle Durability test - Vehicle Corrosion test - Component FMEA/DVP&R	3	36	[4 2.5.1] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		6	2	2	24
					[4 2.6] Tolerance stack-up	2	- Prototype vehicle builds - GD&T Reviews - Fresh Eyes Reviews - VSA Study	3	36	[4 2.6.1] Initiate onsite VSA support	J. Nantais 4/03		6	2	2	24
	[4.3] Vehicle leans greater than 10 mm side-to-side	- Cust. dissat. with vehicle appearance (4) - Deg. hand ing (6) - Tire wear (5) - Wheel fight (5) - Vehicle drifts (6) - Clear-vision off (4)	6		[4.3.1] Center of gravity ocation is offset to one side	2	- Weight Engineering analysis - Weigh prototype vehicles - Fresh Eyes Reviews	3	36	[4.3.1.1] Get updated we ght projections after each prototype build	H. Hess Post AP3/Post CP		6	2	2	24
					[4.3.2] Spring left to right variation too large but w thin spec for load	2	- Batch shipping of max/ mean/min load springs after supp ier inspection	3	36	[4.3.2.1] None						
					[4.3.3] Tolerance stack-up	2	- Prototype vehicle builds - GD&T Reviews - Fresh Eyes Reviews - VSA Study	3	36	[4.3.3.1] Initiate onsite VSA support	J. Nantais 4/03		6	2	2	24

Item/Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause/ Mechanism of Failure	Occ	Current Design Controls	Det	RPN	Recommended Action	Responsibility and Target Completion Date	Action Actions Taken	Sev	Occ	Det	RPN
					[4.3.4] Spring sag	2	- Vehicle Durability tests - Vehicle Corrosion test - Component FMEA/DVP&R	3	36	[4.3.4.1] Develop/ mplement system level bench test procedure for early durability proveout	P. Trujillo 4/03		6	2	2	24
					[4.3.5] Shock tower or spring seat fai ure	2	- Vehicle Durability test - Vehicle Corrosion test - Component FMEA/DVP&R	3	36	[4.3.5.1] Develop/ mplement system level bench test procedure for early durability proveout	P. Trujillo 4/03		6	2	2	24
[5] Secure unsprung mass to sprung mass	[5.1] Unable to secure unsprung mass to sprung mass or partly secures	- Vehicle operable only to maneuver safely to roadside (7) - Degraded handling (7)	7		[5.1.1] Joint/Fastener failure	2	- Vehicle Durability tests - Vehicle Corrosion test - Component FMEA/DVP&R	3	42	[5.1.1.1] Review joint des gns with Fastener CPS	C. Hodges 4/03		7	2	2	28
										[5.1.1 2] Develop/ mplement system level bench test procedure for early durability proveout	P. Trujillo 4/03		7	2	2	28
					[5.1.2] Suspension arm fa lure (radius arm, track bar, brackets)	2	- Vehicle Durability tests - Vehicle Corrosion test - Component FMEA/DVP&R	3	42	[5.1.2.1] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		7	2	2	28
				YS	[5.1.3] Shock failure	4	- Vehicle Durability tests - Vehicle Corrosion test - Component FMEA/DVP&R	3	84	[5.1.3.1] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		7	4	2	56
[6] Provide target suspension travels: Maintain WCR clearances between adjacent components throughout travel Reference WCR # ??	[6.1] Less than target jounce travel	- Ride harshness (7) - Degraded durability (5) - Vehicle cannot support rated load (7)	7		[6.1.1] Tolerance stack-up	2	- CAD design/compatabil ty reviews - Suspension Jounce test - GD&T reviews	2	28	[6.1.1.1] None						
					[6.1.2] Damaged shock	2	- Vehicle Durability tests - Vehicle Corrosion test - Component FMEA/DVP&R - CAD design/compatabil ty reviews	3	42	[6.1.2.1] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		7	2	2	28
					[6.1.3] Spring solid height too long	2	- Component FMEA/DVP&R	3	42	[6.1.3.1] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		7	2	2	28
					[6.1.4] Shock compressed length too long	2	- Component FMEA/DVP&R	3	42	[6.1.4.1] Develop/ mplement system level bench test procedure for early durability proveout	P. Trujillo 4/03		7	2	2	28
					[6.1.5] Shock tower or spring seat fai ure	2	- Vehicle Durability tests - Vehicle Corrosion test - Component FMEA/DVP&R	3	42	[6.1.5.1] Develop/ mplement system level bench test procedure for early durability proveout	P. Trujillo 4/03		7	2	2	28
	[6.2] More than target jounce travel	- Component interference (7) - Tire contacts surrounding components when jounced beyond designed metal-to-metal condition (8)	8		[6 2.1] Tolerance stack-up	2	- CAD design/compatabil ty reviews - WCR for tire envelop clearance - Suspension Jounce test - GD&T Reviews	3	48	[6 2.1.1] Initiate onsite VSA support	J. Nantais 4/03		8	2	2	32
					[6 2.2] Jounce bumper rate curve too soft	3	- Vehicle durabi ity test - Development evaluations to check for strikethrough - Component FMEA/DVP&R	2	48	[6 2.2.1] None						
					[6 2.3] Shock tower or spring seat fai ure	2	- Vehicle Durability tests - Vehicle Corrosion test - Component FMEA/DVP&R	3	48	[6 2.3.1] Develop/ mplement system level bench test procedure for early durability proveout	P. Trujillo 4/03		8	2	2	32
				YS	[6 2.4] Jounce Bumper fai ure or missing	4	- Vehicle Durability tests - Component FMEA/DVP&R	3	96	[6 2.4.1] Develop/ mplement system level bench test procedure for early durability proveout	P. Trujillo 4/03		8	4	2	64
					[6 2.5] Jounce Bumper metal stop failure	2	- Vehicle Durability tests - Vehicle Corrosion test - Component FMEA/DVP&R	3	48	[6 2.5.1] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		8	2	2	32
	[6.3] Less than target rebound travel	- Ride harshness (7) - Degraded durability (5)	7		[6.3.1] Tolerance stack-up	2	- CAD design/compatabil ty reviews - Suspension Jounce test - GD&T Reviews	2	28	[6.3.1.1] None						
					[6.3.2] Shock extended length too short	2	- CAD design/compatabil ty reviews - Component FMEA/DVP&R	3	42	[6.3.2.1] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		7	2	2	28
					[6.3.3] Bent shock rod	3	- Vehicle Durability tests - Vehicle Corrosion test - CAD design/compatabil ty reviews - Component FMEA/DVP&R	3	63	[6.3.3.1] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		7	3	2	42
					[6.3.4] Shock tower damage	2	- Vehicle Durability tests - Vehicle Corrosion test - Component FMEA/DVP&R	3	42	[6.3.4.1] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		7	2	2	28
	[6.4] More than target rebound travel	- Component interference (7) - Coil Spring unseated resulting in spring loss (7) - Brake jounce hose damaged (8)	8		[6.4.1] Tolerance stack-up	2	- CAD design/compatabil ty reviews - Suspension jounce test - GD&T Reviews	2	32	[6.4.1.1] None						
					[6.4.2] Shock extended length too long	2	- CAD design/compatabil ty reviews - Component FMEA/DVP&R	3	48	[6.4.2.1] Develop/ mplement system level bench test procedure for early durability proveout	P. Trujillo 4/03		8	2	2	32

Item/Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause/ Mechanism of Failure	Occ	Current Design Controls	Det	RPN	Recommended Action	Responsibility and Target Completion Date	Action Actions Taken	Sev	Occ	Det	RPN
					[6.4.3] Shock failure	3	- Vehicle Durability tests - Vehicle Corrosion test - Component FMEA/DVP&R	3	72	[6.4.3.1] Develop/ mplement system level bench test procedure for early durability proveout	P. Trujillo 4/03		8	3	2	48
					[6.4.4] Shock tower fa lure	2	- Vehicle Durability tests - Vehicle Corrosion test - Component FMEA/DVP&R	3	48	[6.4.4.1] Develop/ mplement system level bench test procedure for early durability proveout	P. Trujillo 4/03		8	2	2	32
					[6.4.5] Joint/Fastener failure	2	- Vehicle Durability tests - Vehicle Corrosion test - Component FMEA/DVP&R	3	48	[6.4.5.1] Review joint des gns with Fastener CPS	C. Hodges 4/03		8	2	2	32
										[6.4.5 2] Develop/ mplement system level bench test procedure for early durability proveout	P. Trujillo 4/03		8	2	2	32
	[6.5] Intermittent jounce travel	- Ride harshness (7) - Degraded durability of components (5) - Loss of load carrying capability (5)	7		[6.5.1] Stones get lodged in suspension system	1	- Vehicle durabi ity tests - Suspension stone/sand impact test - Stone pecking test - Post durabi ity Fresh Eyes Reviews	2	14	[6.5.1.1] None						
		- Component interference (7)			[6.5.2] Shock hydrau ic lock out	2	- Vehicle Durability tests - Component FMEA/DVP&R	3	42	[6.5.2.1] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		7	2	2	28
	[6.6] Less than target clearances	- Component interference (7) - Degraded durability of components (5) - Degraded NVH (6) - Snow chains don"t fit (5)	7		[6.6.1] Components dimensions ncorrect	3	- CAD design clearance checklist - CAD design/compatabil ty reviews - Fresh Eyes Reviews - Prototype vehicle builds - Component FMEA/DVP&R	2	42	[6.6.1.1] None						
					[6.6.2] Incorrect CAD data	3	- Component health charts - Vehicle sign-offs - CAD design/compatabil ty reviews	3	63	[6.6.2.1] None						
				YS	[6.6.3] Overlooked ne ghboring system in CAD models	4	- CAD design/compatabil ty reviews - Vehicle sign-offs	2	56	[6.6.3.1] None						
[7] Provide target suspens on kinematic properties Toe, caster, camber, lat. and long. position vs. travel Scrub radius Kingpin offset and inclination Roll center height Targets in FDVS	[7.1] Kinematic properties not at target levels	- Degraded handl ng - Degraded steering - Tire wear - Brake pull - Tire squeal	7		[7.1.1] Incorrect hardpoint geometry spec fied	2	- ADAMS analysis - Smart Chassis - K&C vehicle lab test - Vehicle Dynamics development - SDS SU-0002 Nominal Ackerman, Caster, Camber, Toe Settings	2	28	[7.1.1.1] None						
				YS	[7.1.2] Tolerance stack-up	4	- VSA study - GDT reviews	3	84	[7.1.2.1] Initiate onsite VSA support	J. Nantais 4/03		7	4	2	56
					[7.1.3] Component yie ding (rad us arms, track bar, brackets, frame)	2	- Vehicle Durability tests - Vehicle Corrosion test - Component FMEA/DVP&R	3	42	[7.1.3.1] Add K&C vehicle test after vehicle durabil ty			7	2	2	28
										[7.1.3 2] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		7	2	2	28
					[7.1.4] Interaction of bushing compliances w th kinematics	2	- ADAMS analysis - K&C vehicle lab test - SDS SU-0763 Suspension Bushing Characterization	2	28	[7.1.4.1] None						
	[7.2] Scrub radius > target level	- Brake pull - Steering wheel fight	7		[7 2.1] Incorrect hardpoint geometry spec fied	2	- ADAMS analysis - Smart Chassis	1	14	[7 2.1.1] None						
	[7.3] Kingpin offset > target level	- Brake pull - Steering wheel fight	7		[7.3.1] Incorrect hardpoint geometry spec fied	2	- ADAMS analysis - Smart Chassis	1	14	[7.3.1.1] None						
	[7.4] Kingpin inclination too large/small	- Tire wear - Degraded handling	7		[7.4.1] Incorrect hardpoint geometry spec fied	2	- ADAMS analysis - Smart Chassis	1	14	[7.4.1.1] None						
	[7.5] Percent Ackerman < target level	- Tire wear - Tire squeal	6		[7.5.1] Incorrect hardpoint geometry spec fied	2	- ADAMS analysis - Smart Chassis	2	24	[7.5.1.1] None						
	[7.6] Driveline NVH	- Customer dissatisfaction	4		[7.6.1] Suspension geometry allows excessive slip yoke travel during jounce/rebound	3	- R202 drive evaluation	3	36	[7.6.1.1] None						
					[7.6.2] Suspension geometry allows excessive pinion angle variation	3	- R202 drive evaluation - ADAMS analysis	3	36	[7.6.2.1] None						
[8] Provide correct static a ignment -toe, caster, camber and clear vision -meet R&H health chart alignment variab lity targets Targets in FDVS	[8.1] Incorrect static alignment setting	- Tire wear - Vehicle drifts - Degraded steering feel - Degraded steering returnabi ity - Degraded vehicle dynamics	7	YS	[8.1.1] Plant end-of-line alignment set process capab lity (toe, clear vision)	4	- VSA study - Process control charts	3	84	[8.1.1.1] Initiate onsite VSA support	J. Nantais 4/03		7	4	2	56
				YS	[8.1.2] Plant / Supplier trend set caster	4	- VSA study - Process control charts	3	84	[8.1.2.1] Initiate onsite VSA support	J. Nantais 4/03		7	4	2	56
					[8.1.3] Alignment change over time due to joint slippage	3	- Vehicle Durability tests - Curb impact test - Railcar/haulaway test - Component FMEA/DVP&R	3	63	[8.1.3.1] Review joint des gns with Fastener CPS	C. Hodges 4/03		7	3	2	42
										[8.1.3 2] Develop/ mplement system level bench test procedure for early durability proveout	P. Trujillo 4/03		7	3	2	42
				YS	[8.1.4] Alignment change over time/ temperature due to bushing creep	4	- Vehicle Durability tests - Component FMEA/DVP&R	3	84	[8.1.4.1] Verify a ignment during vehicle durabil ty testing			7	4	2	56
					[8.1.5] Insufficient component strength (yielding, damage)	2	- Vehicle Durability tests - Component FMEA/DVP&R	3	42	[8.1.5.1] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		7	2	2	28

Item/Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause/ Mechanism of Failure	Occ	Current Design Controls	Det	RPN	Recommended Action	Responsibility and Target Completion Date	Action Actions Taken	Sev	Occ	Det	RPN
	[8.2] Cannot set a ignment	- Customer dissatisfaction	7		[8 2.1] Insufficient adjustment capabi ity design in system or steering	3	- VSA study	3	63	[8 2.1.1] Initiate onsite VSA support	J. Nantais 4/03		7	3	2	42
[9] Provide target suspension compliance -toe, caster, camber, lat. and long. positions vs. lat. force, long. force and aligning torque	[9.1] Incorrect initial suspension compliance	- Degraded handling - Degraded steering - Increased tire wear	7		[9.1.1] Incorrect bushing rates specified	2	- ADAMS analysis - K&C vehicle lab test - Vehicle Dynamics testing	2	28	[9.1.1.1] None						
					[9.1.2] Incorrect rad us arm st ffnesses specified	2	- K&C vehicle lab test - Vehicle Dynamics testing	2	28	[9.1.2.1] None						
					[9.1.3] Bushing rate varies too much but within target	3	- ADAMS analysis	3	63	[9.1.3.1] None						
	[9.2] Degraded suspension compliance	- Degraded handl ng - Degraded steering - Increased tire wear	7	YS	[9 2.1] Bushing rate changes over time	4	- Vehicle Durability tests - Component FMEA/DVP&R	3	84	[9 2.1.1] Measure bushing rates after vehicle durabil ty			7	4	2	56
										[9 2.1 2] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		7	4	2	56
	[9.3] Intermittent suspension compliance	- Degraded handling - Degraded steering - Increased tire wear	7		[9.3.1] Bushing rate changes due to temperature	3	- Vehicle evaluations in hot/cold climate - Component FMEA/DVP&R	3	63	[9.3.1.1] Conduct bushing rate test at hot/cold temperatures			7	3	2	42
[10] Provide target suspension modal properties	[10.1] Incorrect suspension modal properties	- Increased brake roughness sensitivity - Increased wheel imbalance sensitivity - Degraded ride - Degraded NVH	7		[10.1.1] Incorrect or no modal target specified	3	- Vehicle brake roughness sensitivity test - Vehicle 4 post test - Vehicle CP2 lab test - R202 drive evaluations - NVH development - CAE modal analysis	2	42	[10.1.1.1] None						
					[10.1 2] Incorrect component mass (bushing, coil spring, shock, radius arm)	3	- Vehicle brake roughness sensitivity test - Vehicle 4 post test - Vehicle CP2 lab test - R202 drive evaluations - NVH development - Vehicle ride development - CAE modal analysis	2	42	[10.1 2.1] None						
					[10.1.3] Incorrect component st ffness (bushing, coil spring, shock, control arm)	3	- Vehicle brake roughness sensitivity test - Vehicle 4 post test - Vehicle CP2 lab test - R202 drive evaluations - NVH development - Vehicle ride development - CAE modal analysis	2	42	[10.1.3.1] None						
	[10 2] Shimmy/Wheel fight	- Customer dissatisfaction - Steering nimble	7		[10 2.1] Improper st ffness for frame, body, unsprung mass	3	- ADAMS modeling - CAE& DOE Wheel fight	3	63	[10 2.1.1] None						
					[10 2 2] Improper KPO, KPI, shock ratio or damping	3	- ADAMS modeling - CAE & DOE Wheel fight - steering wheel torsion testing (Refer to Steering DFMEA)	3	63	[10 2 2.1] None						
					[10 2.3] Improper suspension geometry	2	- ADAMS modeling - K&C testing	3	42	[10 2.3.1] None						
					[10 2.4] Incorrect shock tuning	3	- CAE/DOE for shimmy	2	42	[10 2.4.1] None						
					[10 2.5] Improper steering gear mounting or location	2	- CAE/DOE for shimmy	3	42	[10 2.5.1] None						
[11] Provide target suspension ride frequency and roll st ffness Targets in FDVS	[11.1] R de frequencies outside of target range	- Degraded ride - Increased brake p tch	7		[11.1.1] Incorrect coil spring rate spec fied	2	- Ride frequency design calculations - ADAMS analysis - K&C vehicle lab test - R202 drive evaluations - Vehicle ride development	2	28	[11.1.1.1] None						
					[11.1 2] Incorrect bushing torsional rates specified	2	- Ride frequency design calculations - ADAMS analysis - K&C vehicle lab test - Vehicle ride development	2	28	[11.1 2.1] None						
					[11.1.3] Vehicle mass not at target	3	- Weight engineering analysis - Weigh prototype vehicles - Vehicle ride development	3	63	[11.1.3.1] Get updated weight projections after each prototype build	H. Hess Post AP3/Post CP		7	3	3	63
	[11 2] Ride frequencies degrade over time	- Degraded ride	7		[11 2.1] Change in co l spring rate over time	3	- Vehicle Durability tests - Component FMEA/DVP&R	3	63	[11 2.1.1] Measure coil spring rate after vehicle durabil ty			7	3	2	42
										[11 2.1 2] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		7	3	2	42
				YS	[11 2 2] Change in bushing torsional rate over time	4	- Vehicle Durability tests - Component FMEA/DVP&R	3	84	[11 2 2.1] Measure bushing rates after vehicle durabil ty			7	4	2	56
										[11 2 2 2] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		7	4	2	56

Item/Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause/ Mechanism of Failure	Occ	Current Design Controls	Det	RPN	Recommended Action	Responsibility and Target Completion Date	Action Actions Taken	Sev	Occ	Det	RPN
	[11.3] Roll stiffness outside target range	- Degraded ride (head toss) - Degraded handling	7		[11.3.1] Incorrect coil spring rate spec fied	2	- ADAMS analysis - K&C vehicle lab test - Vehicle handling development - R202 drive evaluations	2	28	[11.3.1.1] None						
					[11.3 2] Incorrect stab bar diameter specified	2	- ADAMS analysis - K&C vehicle lab test - Vehicle handling development - R202 drive evaluations	2	28	[11.3 2.1] None						
					[11.3.3] Incorrect bushing torsional rates specified	2	- ADAMS analysis - K&C vehicle lab test - Vehicle handling development - R202 drive evaluations	2	28	[11.3.3.1] None						
					[11.3.4] Incorrect axle bushing radial rates specified	2	- ADAMS analysis - K&C vehicle lab test - Vehicle handling development - R202 drive evaluations	2	28	[11.3.4.1] None						
	[11.4] Roll stiffness degrades over t me	- Degraded handl ng	7		[11.4.1] Change in co l spring rate over time	3	- Vehicle Durability tests - Component FMEA/DVP&R	3	63	[11.4.1.1] Measure coil spring rate after vehicle durabil ty			7	3	2	42
										[11.4.1 2] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		7	3	2	42
				YS	[11.4 2] Change in axle bushing radial rate over time	4	- Vehicle Durability tests - Component FMEA/DVP&R	3	84	[11.4 2.1] Measure bushing rates after vehicle durabil ty			7	4	2	56
										[11.4 2 2] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		7	4	2	56
				YS	[11.4.3] Change in bushing torsional rate over time	4	- Vehicle Durability tests - Component FMEA/DVP&R	3	84	[11.4.3.1] Measure bushing rates after vehicle durabil ty			7	4	2	56
										[11.4.3 2] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		7	4	2	56
[12] Provide target suspension anti-dive and anti-l ft properties to support vehicle pitch control	[12.1] Anti-dive too low	- Increased brake p tch	6		[12.1.1] Incorrect suspension hardpoints specified	2	- ADAMS analysis - K&C vehicle lab test - Vehicle Dynamics testing	2	24	[12.1.1.1] None						
	[12 2] Anti-dive too high	- Degraged ride (harsh)	6		[12 2.1] Incorrect suspension hardpoints specified	2	- ADAMS analysis - K&C vehicle lab test - Vehicle Dynamics testing	2	24	[12 2.1.1] None						
	[12.3] Anti-lift too low	- Increased accel. pitch	6		[12.3.1] Incorrect suspension hardpoints specified	2	- ADAMS analysis - K&C vehicle lab test - Vehicle Dynamics testing	2	24	[12.3.1.1] None						
	[12.4] Anti-lift too high	- Degraded ride (harsh)	6		[12.4.1] Incorrect suspension hardpoints specified	2	- ADAMS analysis - K&C vehicle lab test - Vehicle Dynamics testing	2	24	[12.4.1.1] None						
[13] Provide target ride and steering axis friction	[13.1] R de friction too high	- Degraded ride (harsh)	6		[13.1.1] Component friction targets cascaded incorrectly or not cascaded	2	- K&C vehicle lab test - Vehicle Dynamics testing	2	24	[13.1.1.1] None						
					[13.1 2] Components do not meet cascaded targets (ball joints, shock, coil spring, stab bar	3	- Component lab friction tests	2	36	[13.1 2.1] None						
	[13 2] Steering axis friction too high	- Degraded steering feel - Degraded steering returnability	6		[13 2.1] Component friction targets cascaded incorrectly or not cascaded	3	- K&C vehicle lab test - Vehicle Dynamics testing	2	36	[13 2.1.1] None						
				YS	[13 2 2] Components do not meet cascaded targets (ball joints)	4	- Component lab friction tests	2	48	[13 2 2.1] None						
	[13.3] Steering axis friction too low	- Degraded steering feel - Degraded steering returnability	6		[13.3.1] Component friction targets cascaded incorrectly or not cascaded	3	- K&C vehicle lab test - Vehicle Dynamics testing	2	36	[13.3.1.1] None						
				YS	[13.3 2] Components do not meet cascaded targets (ball joints)	4	- Component lab friction tests	2	48	[13.3 2.1] None						
					[13.3.3] Ba l joint friction increases too much over time	3	- Vehicle durabi ity tests	3	54	[13.3.3.1] None						
[14] Provide target damping force between sprung and unsprung mass Bushings +/-15% Shock +/-10% Shock degredation +/-15%	[14.1] Initial damping force too high/low	- Degraded ride - Degraded handling	6		[14.1.1] Incorrect shock forces specified	3	- Vehicle ride development - R202 drive evaluations	3	54	[14.1.1.1] None						
					[14.1 2] Incorrect bushing damping specified	3	- Vehicle ride development - R202 drive evaluations - NVH CAE	3	54	[14.1 2.1] None						
					[14.1.3] Shock damp ng forces vary too much but w thin specification	3	- Vehicle ride development - R202 drive evaluations	3	54	[14.1.3.1] None						
	[14 2] Intermittent damping force too high/low	- Degraded ride - Degraded handling	6	YS	[14 2.1] Shock forces vary too much with temperature	4	- Vehicle ride development - Component FMEA/DVP&R	2	48	[14 2.1.1] None						
				YS	[14 2 2] Shock forces lag	4	- Vehicle ride development - R202 drive evaluations - Component FMEA/DVP&R	2	48	[14 2 2.1] None						
	[14.3] Damping force degraded over time	- Degraded ride - Degraded handling	6	YS	[14.3.1] Shock forces degrade over time	4	- Vehicle Durability tests - Component FMEA/DVP&R	3	72	[14.3.1.1] Test shocks after vehicle durability			6	4	2	48
										[14.3.1 2] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		6	4	2	48

Item/Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause/ Mechanism of Failure	Occ	Current Design Controls	Det	RPN	Recommended Action	Responsibility and Target Completion Date	Action Actions Taken	Sev	Occ	Det	RPN
					[14.3 2] Bushing damping degrades over time	3	- Vehicle Durability tests - Component FMEA/DVP&R	3	54	[14.3 2.1] Test bushings after vehicle durab lity			6	3	2	36
										[14.3 2 2] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		6	3	2	36
[15] Vehicle Handling (Rough Road) Maintain tire orientation and contact with road (Rough Road includes: cobblestone, gravel, cracked concrete, rail road track, wash board dirt road)	[15.1] Consumer does not feel confident about being in control	- Loss of steering control - Degraded handling	7		[15.1.1] Incorrect bushing or mounts by design	3	- 4" Pot hole test - Development Drive Evaluations - R202 drive evaluations - Rough Road test	3	63	[15.1.1.1] None						
					[15.1 2] Spring/shock tuning	3	- Drive Evaluation - R202 drive evaluations	3	63	[15.1 2.1] None						
	[15 2] Dynamic Toe changes	- Reduced steering stabil ty - Steering wheel misalignment - premature tire wear - wanders	5		[15 2.1] Suspension geometry changes over bumps due to incorrectly designed suspension geometry	3	- CAE ADAMS model - CAE ADAMS variations study - CAE simulated camber curves - K&C machine check & analysis - Development drive evaluation - R202 drive evaluations	3	45	[15 2.1.1] None						
				YS	[15 2 2] Incorrect torque on fastener causing wheel mis-a ignment	4	- Vehicle Spike stop test - Vehicle Durability tests - A ignment check after haulaway - Component FMEA/DVP&R	3	60	[15 2 2.1] Review joint designs w th Fastener CPS	C. Hodges 4/03		5	4	2	40
										[15 2 2 2] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		5	4	2	40
				YS	[15 2.3] Premature wear of bushings or ball jo nts	4	- ADAMS Model / CAE Analysis - Bushing Characterization	3	60	[15 2.3.1] None						
	[15.3] Dynamic camber angle changes	- Premature tire wear (7) - Tire noise (7) - Pull or drift (7) - Reduced cornering capability (7)	7	YS	[15.3.1] Suspension geometry changes over bumps	4	- ADAMS Model / CAE Analysis - K&C machine check & analysis	3	84	[15.3.1.1] None						
				YS	[15.3 2] Incorrect suspension geometry	4	- ADAMS Model / CAE Analysis - K&C machine check & analysis	3	84	[15.3 2.1] None						
				YS	[15.3.3] Alignment set incorrectly	4	- ADAMS Model / CAE Analysis - K&C machine check & analysis	3	84	[15.3.3.1] None						
	[15.4] Premature component wear due to high temperature usage (taxi, police) including areas of high brake usage	- Customer dissatisfaction - Increased warranty costs - Loss of control - Reduced steering stabil ty - Misalignment - Ride height degradation	7	YS	[15.4.1] Actual temperature usage higher than designed for ba l joint seal , tie rod seals (taxi, police) including areas of high brake usage	4	- ADAMS Model / CAE Analysis - Bushing Characterization	3	84	[15.4.1.1] None						
					[15.4 2] Under designed shocks	3	- Drive Evaluation - Component FMEA/DVP&R	3	63	[15.4 2.1] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		7	3	2	42
					[15.4.3] Under des gned Jounce Bumper	3	- Supplier to use Ford approved materials - Component FMEA/DVP&R	3	63	[15.4.3.1] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		7	3	2	42
[16] Vehicle Handling - Straight ahead stab lity without dr ft, pull, wander, shimmy while driving on crown roads and cross wind environmental cond tion	[16.1] Vehicle drifts/pulls while driving straight ahead	- Customer dissatisfaction - Constant Steering correction	7		[16.1.1] Incorrect spring attachment point location by design	2	- Vehicle eva uation - Vehicle Design Aid	3	42	[16.1.1.1] None						
				YS	[16.1 2] Side to s de r de height	4	- Prototype vehicle bui ds - Component FMEA/DVP&R	2	56	[16.1 2.1] None						
					[16.1.3] Offset vehicle loading	3	- Vehicle weight engineering analysis	3	63	[16.1.3.1] Get updated weight projections after each prototype build	H. Hess Post AP3/Post CP		7	4	2	56
					[16.1.4] Excessive thrust angle	3	- A ignment check - Vehicle ride evaluation - R202 drive evaluations	3	63	[16.1.4.1] None						
				YS	[16.1.5] - Vehicle sensitivity to misalignment - Caster angle, toe angle, kingpin angle and scrub radius may not designed to be optimum for the vehicle package - Alignment not set within specified limits	4	- Design for EOL alignment - R202 drive evaluation - ADAMS model - conduct an evaluation using vehicles set outside alignment specs - VSA Study	3	84	[16.1.5.1] Initiate ons te VSA support	J. Nantais 4/03		7	4	2	56
					[16.1.6] Incorrect tire pressure specified, actual Tire pressure fell out of spec or uneven tire pressure from left to right	3	- Review FMEA with tire engineer	3	63	[16.1.6.1] None						
				YS	[16.1.7] Wheel alignment degradation over time	4	- Assess impact of alignment degradation during vehicle durabi ity	4	112	[16.1.7.1] None						
				YS	[16.1.8] Tire properties - RSAT and Conicity	5	See tire FMEA/DVP&R	3	105	[16.1.8.1] None						

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	[16 2] Vehicle wanders	- Customer dissatisfaction due to steering requiring constant correction	7	YS	[16 2.1] H gh friction n Steer ng and/or Suspension system	4	- SDS CS-0077 Suspension Friction about Steered Axes - SDS CS-0078 Suspension System Friction vs. Wheel Travel	3	84	[16 2.1.1] None						
					[16 2 2] Incorrect tire pressure	3	See tire FMEA/DVP&R	3	63	[16 2 2.1] None						
				YS	[16 2.3] Incorrect allowance for bushing comp iance	4	- Subjective evaluation - Component FMEA/DVP&R	3	84	[16 2.3.1] None						
				YS	[16 2.4] Insufficient caster angle	4	- SDS SU-0002 Nominal Ackerman, Caster, Camber, Toe Settings	3	84	[16 2.4.1] None						
	[16.3] Vehicle dog tracks greater than 30 mm	- Customer dissatisfaction	5		[16.3.1] Frame width clearances specified too large	3	- CAD design clearance checklist - CAD design/compatabil ty reviews - GD&T reviews - Prototype vehicle builds - Component FMEA/DVP&R	3	45	[16.3.1.1] None						
					[16.3 2] Excessive thrust angle	3	- Vehicle eva uation - Review vehicle fit for possible mis-builds - Tolerance stack-up	3	45	[16.3 2.1] Initiate ons te VSA support	J. Nantais 4/03		5	3	2	30
				YS	[16.3.3] Excessive Front and/or Rear Toe change due to Suspension travel	4	- ADAMS model - VSA Study	3	60	[16.3.3.1] Initiate ons te VSA support	J.Nantais 4/03		5	4	2	40
[17] Vehicle Handling (Smooth Road) Maintain tire orientation with road (Suspension/ball joint/steering column - friction lash)	[17.1] Does not maintain contact with road	- Premature tire wear (7) - Reduced straight ahead stabil ty (7) - Steering returnability degraded - Steering wheel out of position	7	YS	[17.1.1] Toe change due to suspension system comp iance (Incorrect initially and degradation)	4	- ADAMS model - Vehicle Durability tests - Component FMEA/DVP&R	3	84	[17.1.1.1] None						
					[17.1 2] Incorrect steering system locat on and/or comp iance	3	- Vehicle Durability tests - see steering system FMEA	3	63	[17.1 2.1] None						
	[17 2] Misalignment, incorrect camber, undesirable camber change characteristics	- Premature tire wear - Tire Noise - Reduced cornering capability	7		[17 2.1] Geometry compliance (improper camber curves specified)	3	- ADAMS model - Subjective evaluation - Supplier tire wear prediction model - SDS SU-0002 Nominal Ackerman, Caster, Camber, Toe Settings	3	63	[17 2.1.1] None						
					[17 2 2] Spring sag	3	- Vehicle durabi ity tests - Vehicle corrosion test - Component FMEA/DVP&R	3	63	[17 2 2.1] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		7	3	2	42
	[17.3] Misalignment, caster split	- Braking instabil ty - Degraded center feel, - Different steering wheel returnability left & right	7		[17.3.1] Improper caster split by design or process	3	- PFMEA - Pull/dr ft study - SDS SU-0002 Nominal Ackerman, Caster, Camber, Toe Settings - VSA Study	3	63	[17.3.1.1] Initiate ons te VSA support	J. Nantais 4/03		7	3	2	42
	[17.4] Incorrect caster and undesired caster changes	- Degraded center feel (7) - Steering returnability (6) - Harshness (5)	7		[17.4.1] Not optimum geometry for upper and lower ball joints	2	- ADAMS model - Subjective evaluation - K&C checks - Pull/dr ft study	3	42	[17.4.1.1] None						
	[17.5] Braking instabi ity	- Degraded center feel - Returnab lity different side to side	7		[17.5.1] Improper caster split	3	- VSA Study - Refer to PFMEA	4	84	[17.5.1.1] Initiate ons te VSA support	J. Nantais 4/03		7	3	3	63
	[17.6] Incorrect caster angle	- Degraded center feel - Steering returnability	7		[17.6.1] Incorrect caster angle spec or not set to spec	3	- ADAMS Modeling - Vehicle Dynamics test - R202 drive evaluations	4	84	[17.6.1.1]						
[18] Acceptable vehicle handling for cornering situation - constant radius turns as specified (Body roll, tire squeaks	[18.1] Too much oversteer or understeer	- Customer dissatisfaction due to loss of vehicle control	5		[18.1.1] Suspension geometry changes e.g., dynamic toe	3	- ADAMS Modeling - Vehicle Dynamics test - R202 drive evaluations	3	45	[18.1.1.1] None						
					[18.1 2] Vehicle weight distribut on (front to rear)	3	- ADAMS Modeling - Vehicle Dynamics test - R202 drive evaluations	3	45	[18.1 2.1] None						
					[18.1.3] Front sta bar st ffness or front to rear relationship	3	- Subjective Ride Evaluation - K&C testing - R202 drive evaluations	3	45	[18.1.3.1] None						
					[18.1.4] Incorrect spring balance	3	- Subjective ride evaluation - K&C testing - R202 drive evaluations	3	45	[18.1.4.1] None						

Ford Motor Company

POTENTIAL FAILURE MODE AND EFFECTS ANALYSIS - DESIGN FMEA -

_X_ System: 040100 FRONT SUSPENSION SYSTEM, MONOBEAM
___ Subsystem:
___ Component:

Design Responsibility: Suspension Engineering

Key Date:

FMEA Number: DFMEA - Mono

Prepared by: Jerry Nantais / 39-02923 / Tough Tru

Vehicle Program: P131 / 2005
Core Team: C. Hodges J. Nantais H. Hess S. Rollinger P. Trujillo B. Mazany

FMEA Date (Orig.) 19 Mar 2002 (Rev.) 11 Dec 200

Item/Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause/ Mechanism of Failure	Occ	Current Design Controls	Det	RPN	Recommended Action	Responsibility and Target Completion Date	Action Actions Taken	Sev	Occ	Det	RPN
	[18 2] Abrupt transition from understeer to oversteer	- Customer dissatisfaction due to undesirable steering characteristics	5		[18 2.1] Suspension geometry Sta bar sizing	2	- ADAMS Modeling - Vehicle Dynamic (constant radius, Brake in turn tests) - R202 drive evaluations	2	20	[18 2.1.1] None						
					[18 2 2] Spring rate	3	- ADAMS and steering system roll modeling - Vehicle ride evaluation - R202 drive evaluations	3	45	[18 2 2.1] None						
	[18.3] Improper steering feedback	- Customer dissatisfaction	4		[18.3.1] Suspension geometry (KPO, KPI, steering, caster, camber)	4	- ADAMS Modeling - Vehicle Dynamics ride evaluation - R202 drive evaluations	3	48	[18.3.1.1] None						
					[18.3 2] Incorrect tire and/or bushing tuning	3	- Subjective steering evaluation - R202 drive evaluations	2	24	[18.3 2.1] None						
					[18.3.3] High unsprung mass	4	- Review vehicle targets vs. actual	2	32	[18.3.3.1] None						
	[18.4] Incorrect body roll	- Customer dissatisfaction	3		[18.4.1] Comp iance in Suspension	4	- ADAMS modeling - Benchmarking - Review target setting process - Vehicle dynamics testing - R202 drive evaluations	3	36	[18.4.1.1] None						
					[18.4 2] Improper sta bar size/rate/ efficiency	4	- ADAMS modeling - Benchmarking - Review target setting process - Vehicle dynamics testing - R202 drive evaluations	3	36	[18.4 2.1] None						
					[18.4.3] H gh roll center migration/location	4	- ADAMS modeling - Benchmarking - Review target setting process - Vehicle dynamics testing - R202 drive evaluations	3	36	[18.4.3.1] None						
	[18.5] Tire squeaks	- Customer dissatisfaction	3		[18.5.1] Improper understeer/ oversteer	4	- ADAMS Modeling - Vehicle Dynamics testing - Supplier tire development testing - R202 drive evaluations	4	48	[18.5.1.1] None						
					[18.5 2] Impropoer suspension geometry (caster/camber)	4	- ADAMS Modeling - SDS SU-0002 Nominal Ackerman, Caster, Camber, Toe Settings - Vehicle Dynamics testing - Supplier tire development testing - R202 drive evaluations	4	48	[18.5 2.1] None						
					[18.5.3] Incorrect tire compound and construction	4	- ADAMS Modeling - Vehicle Dynamics testing - Supplier tire development testing - R202 drive evaluations	4	48	[18.5.3.1] None						
[19] Acceptable vehicle handling for transient / lane change conditions	[19.1] Improper steering response	- Customer dissatisfaction due to diminished confidence in steering	3		[19.1.1] Suspension geometry induces oversteer	3	- ADAMS Modeling - Vehicle Dynamics testing - R202 drive evaluations	3	27	[19.1.1.1] None						
					[19.1 2] Incorrect shock tuning	3	- Vehicle Dynamics testing - R202 drive evaluations	2	18	[19.1 2.1] None						
					[19.1.3] Shock roll motion control too low	3	- ADAMS Modeling - Vehicle Dynamics testing - R202 drive evaluations	3	27	[19.1.3.1] None						
					[19.1.4] Spring rates too low	3	- ADAMS Modeling - Vehicle Dynamics testing - R202 drive evaluations	3	27	[19.1.4.1] None						
					[19.1.5] Bushings not tuned properly	3	- Vehicle Dynamics testing - R202 drive evaluations	3	27	[19.1.5.1] None						
					[19.1.6] Incorrect tires	3	- Vehicle Dynamics testing - Supplier tire development testing - R202 drive evaluations	2	18	[19.1.6.1] None						
					[19.1.7] Incorrect stabi izer bar design or spring rates	3	- ADAMS Modeling - Vehicle Dynamics testing - R202 drive evaluations	2	18	[19.1.7.1] None						

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	[19 2] Too much oversteer/ understeer	- Customer dissatisfaction due to diminished confidence in steering	5	YS	[19 2.1] Suspension geometry changes (Dynamic toe)	4	- ADAMS Modeling - Vehicle Dynamics testing - R202 drive evaluations	3	60	[19 2.1.1] None						
				YS	[19 2 2] Sta bar stiffness (front, rear and relationship)	4	- Subjective ride evaluation - K&C testing - R202 drive evaluations	2	40	[19 2 2.1] None						
				YS	[19 2.3] Roll couple distribution	4	- Subjective ride evaluation - K&C testing - R202 drive evaluations	2	40	[19 2.3.1] None						
				YS	[19 2.4] Incorrect spring balance	4	- Subjective ride evaluation - K&C testing - R202 drive evaluations	2	40	[19 2.4.1] None						
[20] Braking stabil ty - Stable vehicle under braking conditions including panic stop	[20.1] Vehicle pu ls to left or right	- Customer dissatisfaction	5		[20.1.1] Sensitivity of Suspension to braking (Incorrect scrub radius)	3	- Brake testing - R202 drive evaluations	3	45	[20.1.1.1] None						
	[20 2] Front or rear of the vehicle l fts	- Customer dissatisfaction	5	YS	[20 2.1] Front and rear suspension not balanced	5	- Anti lift / Anti dive - R202 drive evaluations	2	50	[20 2.1.1] None						
				YS	[20 2 2] Excessive upward H point vertical movement	5	- Anti lift / Anti dive - R202 drive evaluations	2	50	[20 2 2.1] None						
	[20.3] Steering wheel shimmy / roughness	- Customer dissatisfaction	5	YS	[20.3.1] Suspension geometry designed incorrectly (KPO, bushing rates, etc)	4	- ADAMS modeling - Vehicle Dynamics testing - R202 drive evaluations - Brake testing	4	80	[20.3.1.1] None						
[21] Isolate vehicle and passengers from NVH due to road/wheel and driveline inputs per cascaded NVH targets	[21.1] Squeak and rattle issues present n suspension	- Customer dissatisfaction (squeak and rattle)	4		[21.1.1] Joint/fastener loose	4	- Vehicle Durability tests - R202 drive evaluations - Vehicle 4 post evaluations - Burke Porter test - Component FMEA/DVP&R	3	48	[21.1.1.1] Review joint designs w th Fastener CPS	C. Hodges 4/03		4	4	2	32
										[21.1.1 2] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		4	4	2	32
					[21.1 2] Bushing squeak (sta bar, sta bar links, shocks, radius arm, track bar)	4	- Vehicle Durability tests - R202 drive evaluations - Vehicle 4 post evaluations - Burke Porter test - Component FMEA/DVP&R	3	48	[21.1 2.1] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		4	4	2	32
					[21.1.3] Shock vent noise or dust cover damaged/loose	4	- Vehicle Durability tests - R202 drive evaluations - Vehicle 4 post evaluations - Burke Porter test - Component FMEA/DVP&R	3	48	[21.1.3.1] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		4	4	2	32
					[21.1.4] Ba l joint lash (stab bar link, track bar)	4	- Vehicle Durability tests - R202 drive evaluations - Vehicle 4 post evaluations - Burke Porter test - Component FMEA/DVP&R	3	48	[21.1.4.1] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		4	4	2	32
					[21.1.5] Coil spring clash	2	- Vehicle Durability tests - - R202 drive evaluations - Vehicle 4 post evaluations - Burke Porter test - Smart Chassis package - Coil supplier CAE modeling - Component FMEA/DVP&R	3	24	[21.1.5.1] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		4	4	2	32
					[21.1.6] Coil spr ng seat squeak	4	- Vehicle Durability tests - R202 drive evaluations - Vehicle 4 post evaluations - Burke Porter test - Component FMEA/DVP&R	3	48	[21.1.6.1] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		4	4	2	32
					[21.1.7] Improper design clearance between components	2	- Vehicle Durability tests - R202 drive evaluations - Vehicle 4 post evaluations - Burke Porter test - Smart Chassis package - Compatab lity reviews - Component FMEA/DVP&R	2	16	[21.1.7.1] None						
	[21 2] Harsh ride on some or a l road surfaces	- Customer dissatisfaction (5) - Joint relaxation (5)	5		[21 2.1] Incorrect bushing material specification	2	- R202 drive evaluations - NVH CAE Analysis	3	30	[21 2.1.1] None						
					[21 2 2] Incorrect coil spring isolator material specification	2	- R202 drive evaluations - NVH CAE Analysis	3	30	[21 2 2.1] None						
					[21 2.3] Worn/broken bushings/mounts	2	- R202 drive evaluations - Vehicle durabi ity tests - Component FMEA/DVP&R	4	40	[21 2.3.1] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		5	2	3	30
					[21 2.4] shock bushings harden in cold temperatures	2	- R202 drive evaluations - Vehicle Environmental Testing	3	30	[21 2.4.1] None						
					[21 2.5] Spring rates incorrectly balanced with rear	2	- R202 drive evaluations - Loading Calculations - ADAMS modeling/ NVH CAE Analysis	3	30	[21 2.5.1] None						

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					[21 2.6] Radius arm bushings recession too small	3	- R202 drive evaluations - ADAMS modeling/ NVH CAE Analysis	3	45	[21 2.6.1] None						
					[21 2.7] Stabilizer bar isolator recession too small	2	- R202 drive evaluations - ADAMS modeling/ NVH CAE Analysis	3	30	[21 2.7.1] None						
					[21 2.8] Incorrect shock calibration specified	2	- R202 drive evaluations - ADAMS modeling/ NVH CAE Analysis	3	30	[21 2.8.1] None						
	[21.3] Does not meet cascaded driveline NVH targets	- Customer dissatisfaction (5)	5		[21.3.1] Suspension geometry allows excessive half-shaft travel during jounce/rebound	2	- ADAMS modeling/ NVH CAE Analysis - CAD design/compatability Reviews - R202 drive evaluations	2	20	[21.3.1.1] None						
	[21.4] Does not meet cascaded road NVH targets	- Customer dissatisfaction (5) - Joint relaxation (5)	5		[21.4.1] Incorrect bushing material specification	2	- R202 drive evaluations - NVH CAE Analysis	3	30	[21.4.1.1] None						
					[21.4 2] Incorrect coil spring isolator material specification	2	- R202 drive evaluations - NVH CAE Analysis	3	30	[21.4 2.1] None						
					[21.4.3] Spring rates incorrectly balanced with rear	2	- R202 drive evaluations - Loading Calculations - ADAMS modeling/ NVH CAE Analysis	3	30	[21.4.3.1] None						
				YS	[21.4.4] Worn bushings/mounts	5	- R202 drive evaluations - Material performance specification testing (incl. finish) - Vehicle durability tests	3	75	[21.4.4.1] None						
					[21.4.5] Joint relaxation due to: - incorrect size specified - incorrect torque specified - inappropriate surface finish	3	- Vehicle Durability Tests - Loading Calculations - Stress/Strain Analysis - Joint Analysis (Clamp Load Study) - Material performance - R202 drive evaluations	3	45	[21.4.5.1] None						
	[21.5] Intermittent vibration exceeds cascaded NVH target	- Customer dissatisfaction (5) - Joint relaxation (5)	5		[21.5.1] Incorrect bushing material specification	2	- R202 drive evaluations - NVH CAE Analysis	4	40	[21.5.1.1] None						
					[21.5 2] Incorrect coil spring isolator material specification	2	- R202 drive evaluations - NVH CAE Analysis	4	40	[21.5 2.1] None						
					[21.5.3] Spring rates incorrectly balanced with rear	2	- R202 drive evaluations - Loading Calculations - ADAMS modeling/ NVH CAE Analysis	4	40	[21.5.3.1] None						
				YS	[21.5.4] Worn bushings/mounts	5	- R202 drive evaluations - Material performance specification testing (incl. finish) - Vehicle durability tests	4	100	[21.5.4.1] None						
					[21.5.5] Joint relaxation due to: - incorrect size specified - incorrect torque specified - inappropriate surface finish	3	- Vehicle Durability Tests - Loading Calculations - Stress/Strain Analysis - Joint Analysis (Clamp Load Study) - Material/Performance - R202 drive evaluations	3	45	[21.5.5.1] None						
[22] Meet manufacturing and assembly requirements: - packaging - tool clearance (Ergonomic related Functions, Failures and Effects are addressed in VO"s PFMEA)	[22.1] Cannot assemble	- No build condition (8)	8	YS	[22.1.1] Tolerance stack up	5	- CAD design/compatability reviews - Fresh Eyes Reviews - Prototype vehicle builds - VSA Study	3	120	[22.1.1.1] Initiate ons te VSA support	J. Nantais 4/03		8	5	2	80
					[22.1 2] Component interference	2	- CAD design/compatability reviews - CAD design clearance checklist - Fresh Eyes Reviews - Prototype vehicle builds - VSA Study	3	48	[22.1 2.1] Initiate ons te VSA support	J. Nantais 4/03		8	2	2	32
					[22.1.3] Insufficient tool clearance	3	- CAD design/compatability reviews - CAD design clearance checklist - Fresh Eyes Reviews - Prototype vehicle builds	3	72	[22.1.3.1] None						

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	[22 2] D fficult to assemble	- Non robust process - Increased assembly time	8	YS	[22 2.1] Tolerance stack up	5	- CAD design/compatabil ty Reviews - Fresh Eyes Reviews - Prototype vehicle builds - VSA Study	3	120	[22 2.1.1] Initiate ons te VSA support	J. Nantais 4/03		8	5	2	80
					[22 2 2] Component interference	2	- CAD design/compatabil ty Reviews - CAD design clearance checklist - Fresh Eyes Reviews - Prototype vehicle builds - VSA Study	3	48	[22 2 2.1] Initiate ons te VSA support	J. Nantais 4/03		8	2	2	32
					[22 2.3] Insufficient tool clearance	3	- CAD design/compatabil ty Reviews - CAD design clearance checklist - Fresh Eyes Reviews - Prototype vehicle builds	3	72	[22 2.3.1] None						
					[22 2.4] Sharp edges on components	3	- Fresh Eyes Reviews - Prototype vehicle builds - Drawing check to ensure - - "No burrs/sharp edges" note included on drawings	1	24	[22 2.4.1] None						
	[22.3] Design al ows misassembly of components	- System does not operate according to design intent - Increased repair time	8		[22.3.1] No obvious anti-symmetry or handedness feature	3	- CAD design/compatabil ty reviews - Fresh Eyes Reviews - Prototype vehicle builds	4	96	[22.3.1.1] None						
				YS	[22.3 2] Multiple fastener sizes in similar attachments	5	- CAD design/compatabil ty reviews - Fresh Eyes Reviews - Prototype vehicle builds	4	160	[22.3 2.1] None						
				YS	[22.3.3] Insufficient labeling of parts - bad location - hard to read / too small - unclear	4	- CAD design/compatabil ty reviews - Fresh Eyes Reviews - Prototype vehicle builds - Parts Branding Directive	5	160	[22.3.3.1] None						
[23] Meet FMVSS and Ford crash requirements	[23.1] Does not meet FMVSS or Ford side, rear and/or offset crash requirements	Noncompliance with FMVSS	10	YC	[23.1.1] Inadequate suspension package resulted in damage to neighboring system components which are critical to FMVSS crash comp iance	2	- CAD design/compatabil ty reviews - CAD design clearance checklist - Crash CAE - Crash testing	2	40	[23.1.1.1] None						
[24] Meet Hoisting requirements: WCR 00.00-P-16	[24.1] Does not meet Hoist lifting requirements	- Damage to suspension components - Partial loss of suspension function (7)	7		[24.1.1] Hoist po nts poorly packaged (too c ose to suspension).	2	- Vehicle Hoist Test - FCSD sign-off	2	28	[24.1.1.1] None						
					[24.1 2] Hoist po nts hard to identify	3	- Vehicle Hoist Test - FCSD sign-off	2	42	[24.1 2.1] None						
					[24.1.3] Insufficient component strength for hoisting	2	- Vehicle Hoist Test - FCSD sign-off	3	42	[24.1.3.1] None						
[25] Meet Jacking requirements	[25.1] Does not meet jacking requirements	- Customer dissatisfaction due to difficulty or inabi ity to access jacking points (6)	6		[25.1.1] Incorrect location of jacking points	2	- Jacking SDS requirements - FCSD sign-off	2	24	[25.1.1.1] None						
					[25.1 2] Insufficient strength of control arm or jack bracket.	2	- Vehicle Durability tests - see Jacking FMEA/DVP&R	2	24	[25.1 2.1] None						
					[25.1.3] Jacking point hard to ident fy.	3	- Jack ng SDS requirements - Owner Guide - Jacking Instruction card - FCSD sign-off	1	18	[25.1.3.1] None						
[26] Meet Wrecker Tow away requirements - no damage to components WCR 00.00-P-14	[26.1] Damage to suspension components or system during wrecker tow away	- Customer dissatisfaction due to damage of suspension components (6) - Partial loss of suspension function (7)	7		[26.1.1] Tow points incorrectly located.	3	- Package study for clearance - Vehicle Wrecker Tow test - FCSD sign-off	2	42	[26.1.1.1] None						
					[26.1 2] Tow points ncorrectly identified/spec fied.	3	- Vehicle Wrecker Tow test - FCSD sign-off	2	42	[26.1 2.1] None						
					[26.1.3] Insufficient package clearance to a low for wrecker.	3	- Vehicle Tow test - FCSD sign-off	3	63	[26.1.3.1] None						
[27] Meet serviceab lity requirements: - avoid new special tools - Provide standard tool and hand clearance - minimum removal of other components (SDS SU-0008)	[27.1] New special tools required	- Increased service cost and repair time (4) - Customer dissatisfaction (4)	4		[27.1.1] Unique fasteners/joints	2	- FCSD Sign-off	3	24	[27.1.1.1] None						

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- no brake bleed requ red SU-0765 -Able to disassemble fasteners - Provide method to reset wheel alignment					[27.1 2] Insufficient clearances for standard tools	2	- CAD design/compatabil ty reviews - CAD design clearance checklist - FCSD Sign-off - VO Sign-off - Packaging Review - Prototype vehicle builds	3	24	[27.1 2.1] None						
	[27 2] Component removal necessary to access suspension components	- Increased service cost and repair time (4) - Customer dissatisfaction (4)	4		[27 2.1] Poor component clearance of vehicle on hoist	2	- Smart Chassis - CAD design clearance checklist - FCSD Sign-off - Fresh Eyes reviews	3	24	[27 2.1.1] None						
	[27.3] Brake bleed necessary to disassemble	- Increased service cost and repair time (4) - Customer dissatisfaction (4)	4		[27.3.1] Poor brake line routing	3	- FCSD Sign-off - see Brake System FMEA/DVP&R	3	36	[27.3.1.1] None						
	[27.4] Substandard too /hand clearance	- Increased service cost and repair time (4) - Customer dissatisfaction (4)	4		[27.4.1] Poor component packaging	2	- CAD design/compatabil ty reviews - CAD design clearance checklist - FCSD Sign-off - VO Sign-off - Packaging Review - Prototype vehicle builds	3	24	[27.4.1.1] None						
	[27.5] Cannot disassemble fasteners	- Increased service cost and repair time (4) - Customer dissatisfaction (4)	4		[27.5.1] Corrosion/dirt	5	- Vehicle Corros on test - Fastener finish selection	3	60	[27.5.1.1] Review fastener f nishes w th Fastener CPS	C. Hodges 4/03		4	5	2	40
					[27.5 2] Thread damage	3	- Vehicle Durability tests - Post durabi ity Fresh Eyes review & teardown	3	36	[27.5 2.1] None						
[28] Uniform Tire Wear - Maintain tire orientation with road (Suspension and steering geometry and/or change to suspension/steering subsystem /components over time/miles)	[28.1] Premature Tire Wear or tire wear in a non-un form manner	- Customer dissatisfaction due to: - Premature tire wear - Uneven tire wear - Irregular tire wear resulting in noise and/ or vibration	5	YS	[28.1.1] Incorrect toe geometry (both kinematic and comp iance)	4	- ADAMS Suspension/steering model - SDS SU-0002 Nominal Ackerman, Caster, Camber, Toe Settings - Durability testing - K&C testing	3	60	[28.1.1.1] None						
				YS	[28.1 2] Incorrect camber geometry	4	- ADAMS Suspension/steer ng model - SDS SU-0002 Nominal Ackerman, Caster, Camber, Toe Settings - Durability testing - K&C testing	3	60	[28.1 2.1] None						
				YS	[28.1.3] Component wear sag/settling -in change to static or dynamic alignment and/or geometry	4	- ADAMS Suspension/steer ng model - SDS SU-0002 Nominal Ackerman, Caster, Camber, Toe Settings - Durability testing - K&C testing	3	60	[28.1.3.1] None						
				YS	[28.1.4] Incorrect Ackerman	4	- ADAMS Suspension/steering model - Durability testing - K&C testing	3	60	[28.1.4.1] None						
				YS	[28.1.5] Incorrect tire inflation pressure	4	- "Suspension Guidelines for Tire Wear and Handling" - Supplier tire wear prediction model - Lab tire wear	3	60	[28.1.5.1] None						
[29] Meet customer damageability requirement for Curb Impact	[29.1] Damaged component Degraded function	- Customer dissatisfaction due to noise and/or poor vehicle handling	6	YS	[29.1.1] Fastener slippage	4	- Curb Impact test - Vehicle Durability tests	3	72	[29.1.1.1] Review fastener finishes w th Fastener CPS	C. Hodges 4/03		6	4	2	48
				YS	[29.1 2] Insufficient component strength	4	- Curb Impact test - Vehicle Durability tests	3	72	[29.1 2.1] Review fastener f nishes w th Fastener CPS	C. Hodges 4/03		6	4	2	48
				YS	[29.1.3] Alignment fell out of spec	4	- Curb Impact test - Vehicle Durability tests	3	72	[29.1.3.1] Review fastener f nishes w th Fastener CPS	C. Hodges 4/03		6	4	2	48

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[30] Meet transportation and sh pping requirements: - no disassembly required - no damage to components - meet alignment specification after shipping WCR 00.00-P-14	[30.1] Damage to suspension components	- Customer dissatisfaction due to partial loss of suspension function (7)	7		[30.1.1] Incorrect tie-down locations or method specified	2	- Rail road / haul away simulation test	3	42	[30.1.1.1] None						
					[30.1 2] Tie-down ocation difficult to identify	3	- Rail road / haul away simulation test	3	63	[30.1 2.1] None						
					[30.1.3] Insufficient component load/yield strength	2	- Vehicle Durability tests - Component FMEA/DVP&R	3	42	[30.1.3.1] None						
	[30 2] Disassembly required during transportation or shipping	- Increase n cost and time	5		[30 2.1] Poor tie-down packaging location (inaccessible)	2	- Rail road / haul away simulation test	3	30	[30 2.1.1] None						
	[30.3] Wheel al gnment out of specification after shipping	- Customer dissatisfaction due to reduced hand ing performance, vehicle pull drift, premature tire wear	6		[30.3.1] Incorrect fastener/torque specifications	3	- Vehicle durabi ity tests - Component FMEA/DVP&R	3	54	[30.3.1.1] Review joint designs w th Fastener CPS	C. Hodges 4/03		6	3	2	36
										[30.3.1 2] Develop/implement system level bench test procedure for early durability proveout	P. Trujillo 4/03		6	3	2	36
					[30.3 2] Insufficient component strength (yielding, damage)	2	- Vehicle Durability tests - Component FMEA/DVP&R	3	36	[30.3 2.1] None						
[31] Meet customer damageability requirements for Car Wash	[31.1] Water intrusion into seals	- Consumer dissatisfaction due to: - Noise - Erratic steering returnability - Component damage due to water intrusion past seal - Noisy function	7		[31.1.1] Inadequate packaging and shielding of ball joints	3	- Car wash rack test - High pressure water test - Lay-out check - Component FMEA/DVP&R	3	63	[31.1.1.1] None						
	[31 2] Damage from wash rack	- Customer dissatisfaction - High warranty	7		[31 2.1] Incorrect package	2	- Hi pressure car wash test - Car wash rack test - Ground clearance WCR	3	42	[31 2.1.1] None						
[32] Meet customer damageability requirement for contact with road debris (gravel roads)	[32.1] Damage to suspension components from premature corrosion and erosion	- Customer dissatisfaction - High warranty	6		[32.1.1] Insufficient corrosion protection	2	- Stone pecking test - Suspension stone/sand impact test - Vehicle corrosion test - Component FMEA/DVP&R	4	48	[32.1.1.1] None						
					[32.1 2] Incorrect ground clearance	3	- Design Aid - Fresh Eyes reviews - Ground clearance SDS/WCR	3	54	[32.1 2.1] None						
					[32.1.3] Boot seals design and packaging not robust for water intrusion	3	- Material spec - Component FMEA/DVP&R	3	54	[32.1.3.1] None						
					[32.1.4] Suspension components not robust to stone pecking	3	- Vehicle durabi ity tests - Vehicle corrosion test - Stone pecking test - Suspension stone/sand impact test - Component FMEA/DVP&R	2	36	[32.1.4.1] None						
[33] Meet customer damageability requirement for salt spray	[33.1] Premature component wear due to usage in corrosive environment	- Customer dissatisfaction - Increased warranty costs - Loss of control - Reduced steering stabil ty - Misalignment - Ride height degradation	6	YS	[33.1.1] Spring corrosion	4	- Vehicle corrosion test - Component FMEA/DVP&R	3	72	[33.1.1.1] None						
				YS	[33.1 2] Loss of function of other components e.g., radius arm, track bar	4	- Vehicle corrosion test - Component FMEA/DVP&R	3	72	[33.1 2.1] None						
	[33 2] Visible red rust seen at show room or at low mileage	- Customer dissatisfaction - Loss of sales - Increased warranty costs	4		[33 2.1] Insufficient corrosion protection	2	- Vehicle corrosion test - Component FMEA/DVP&R	3	24	[33 2.1.1] None						
					[33 2 2] Incorrect material	3	- Vehicle Durability test - Vehicle corrosion test - Component FMEA/DVP&R	3	36	[33 2 2.1] None						
	[33.3] Noise - grunts	- Customer dissatisfaction - Increased warranty costs	4		[33.3.1] Insufficient grease initially or grease wears off or dissolves	4	- Component FMEA/DVP&R	3	48	[33.3.1.1] None						
[34] Meet recyclability requirements	[34.1] Does not meet recyclab lity requirements	- Negative impact to Corporate image (2)	2		[34.1.1] Incorrect materials specified	2	- Materials sign-off	2	8	[34.1.1.1] None						
[35] Meet Parts Branding Directive Requirement	[35.1] Non-Ford brand parts used in service	- Component failure - Customer dissatisfaction - Increased Warranty costs	8		[35.1.1] Components not manufactured with permanent Ford branding (oval and part number)	2	- Part Branding Directive - Drawing checking prior to WERS release	1	16	[35.1.1.1] None						