Insurance Institute for Highway Safety
Crashworthiness Evaluation

Crash Test Report
1998 Nissan Maxima (CF97024)

Vehicle identification number: JN1CA21D8WM905856
Body style: Four-door sedan
Engine/transmission: Transverse 3.0-liter V6, 4-speed automatic, front-wheel drive

Standard crashworthiness features:

Driver and right front passenger front airbags
Dual-locking shoulder belts (front and rear outboard seating positions)
Shoulder belt upper anchorage height adjusters (front seating positions only)
Shoulder belt webbing grabbers (front seating positions only)
Right front and both rear shoulder belt retractors are convertible from emergency to automatic locking for ease of child restraint use

Optional safety features:

Driver and right front passenger seat-mounted side airbags (test vehicle not equipped)
Four-wheel antilock brakes

Vehicle specifications (provided by manufacturer):

Wheelbase:	270 cm
Overall length:	481 cm
Overall width:	177 cm
Curb weight:	1,366 kg

Vehicle specifications (measured):

Front bumper to firewall:	121 cm
Curb weight:	1,408 kg
Test weight:	1,550 kg
Overall width:	176 cm

Nominal test parameters:

40.0 mi/h (64.4 km/h), 40 percent overlap, deformable barrier face with slotted bumper

Crash test date:

December 5, 1997

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Precrash — 1998 Nissan Maxima

Postcrash — 1998 Nissan Maxima

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Summary

A 1998 Nissan Maxima was crash tested on December 5, 1997 into a fixed deformable barrier at 40.1 mi/h (64.5 km/h) and a 40 percent overlap on the driver side. A Hybrid III 50th percentile male dummy was positioned in the driver seat with the lap/shoulder belt fastened.

Measures of intrusion taken after the crash indicate the lower instrument panel in front of the dummy moved rearward 7-10 cm. Resultant intrusion in the driver footwell measured 22 cm at the footrest and 21-30 cm at other places on the toepan. The upper end of the steering column moved upward 10 cm and rearward 7 cm. All doors remained closed during the crash. The right front, right rear, and left rear doors opened with ease after the crash, but the driver door required additional effort to open.

The driver dummy was restrained by a three-point lap/shoulder belt and an airbag. During the crash, 5 cm of webbing spooled off the retractor. The dummy's head, neck, and shoulders loaded the fully inflated airbag and then moved leftward and downward. The head turned slightly to face right before the dummy began to rebound rearward and upward. As the dummy continued rearward and upward, the back of its head contacted both the uppermost belt anchorage hardware on the B-pillar and the head restraint. The dummy then settled back into the seat.

The dummy's head contact against the B-pillar produced a peak resultant head acceleration of 28 g. The left lower tibia had a maximum index of 1.08. The right knee had a maximum displacement of 13 mm, and the right lower tibia had a maximum axial force of 4.5 kN.

Test Conditions

This vehicle had been tested previously in the Institute's Low-Speed Crash Test Program and subjected to an impact on the rear center at 5 mi/h (8 km/h) into a pole. There was no damage on the front of this vehicle.

This test was conducted according to the procedures specified in the IIHS Offset Barrier Crash Test Protocol (Version IV). The Hybrid III dummy positioned in the driver seat was equipped with instrumented lower legs that included feet modified to include two accelerometers and to have a 45 degree dorsiflexion range with soft stops at all extremes of foot-ankle motion. All dummy seating parameters were set according to the procedures specified for Federal Motor Vehicle Safety Standard 208 compliance testing (49 *CFR* Part 571.208 § 11). The dummy's left foot was placed on the footrest.

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Seat back, shoulder belt upper anchorage, and steering column adjustments were set according to the manufacturer's specifications for government crash testing. Other adjustments were set according to the procedure specified for Federal Motor Vehicle Safety Standard 208 compliance testing (49 *CFR* Part 571.208 § 7 and 8). After final positioning of the dummy, measurements from various parts of the dummy to a number of vehicle interior points were made. These measurements and the seat back, shoulder belt upper anchorage, and steering column adjustments are described in the Appendix, Dummy Clearance Measurements.

Vehicle acceleration measurements were made by a triaxial arrangement of accelerometers mounted on the vehicle's longitudinal centerline and 63 cm behind its center of gravity (176 cm behind the front axle). The vehicle speed recorded just prior to impact was 40.1 mi/h (64.5 km/h), and the actual overlap was 40 percent.

Structural Performance

All doors remained closed during the crash. The driver door aperture shortened 10 cm as measured at the lower edge of the window. The right front, right rear, and left rear doors opened with ease after the crash, but the driver door required additional effort to open.

No fuel system leaks were observed after the crash. In addition, no fuel system leaks were observed when the vehicle was rotated onto its right side to allow postcrash photography.

Figure 1 shows the overhead view of the crash deformation. Figure 2A illustrates the precrash and postcrash contour measures of the front bumper cover profile and the resulting permanent crush. Figure 2B illustrates the corresponding measures of both the front bumper reinforcement bar and the upper crossmember of the radiator support. Figure 3 shows the precrash and postcrash views from below. Figure 4 illustrates the deformation of the side rails, floor rails, and engine support members, which are visible in Figure 3.

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Figure 1
Overhead View of Crash Deformation — 1998 Nissan Maxima

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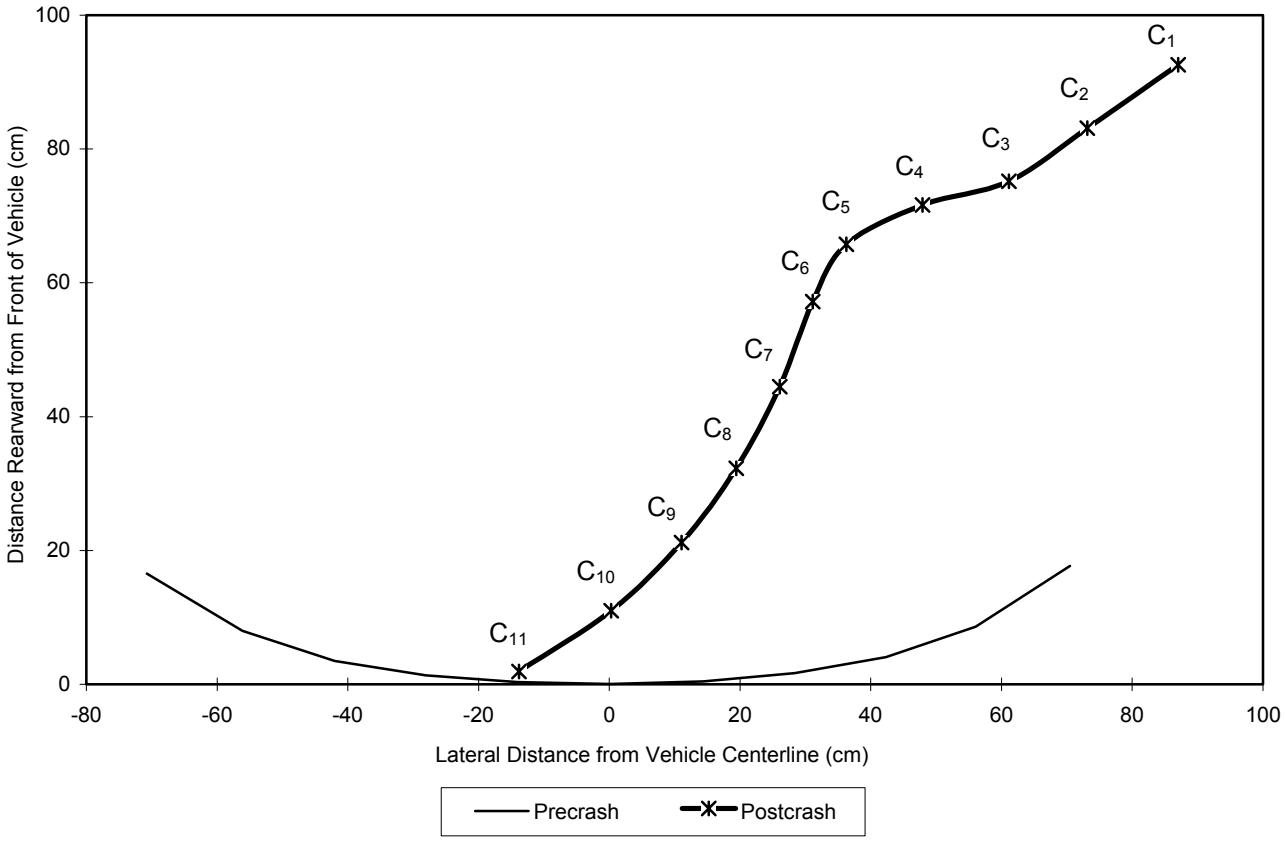
Figure 2
Crush Contour Measurements — 1998 Nissan Maxima

a) Exterior Crush Contour at Bumper Height



	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}
Postcrash Contour (cm)	93	83	75	72	66	57	44	32	21	11	2
Precrash Contour (cm)	18	9	4	2	0	0	0	1	4	8	17
Resulting Crush (cm)	75	74	71	70	66	57	44	31	17	3	-15

The length of the reference line was 141 cm precrash and 101 cm postcrash.

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b) Front Bumper Bar and Upper Radiator Support Crossmember Crush Contour

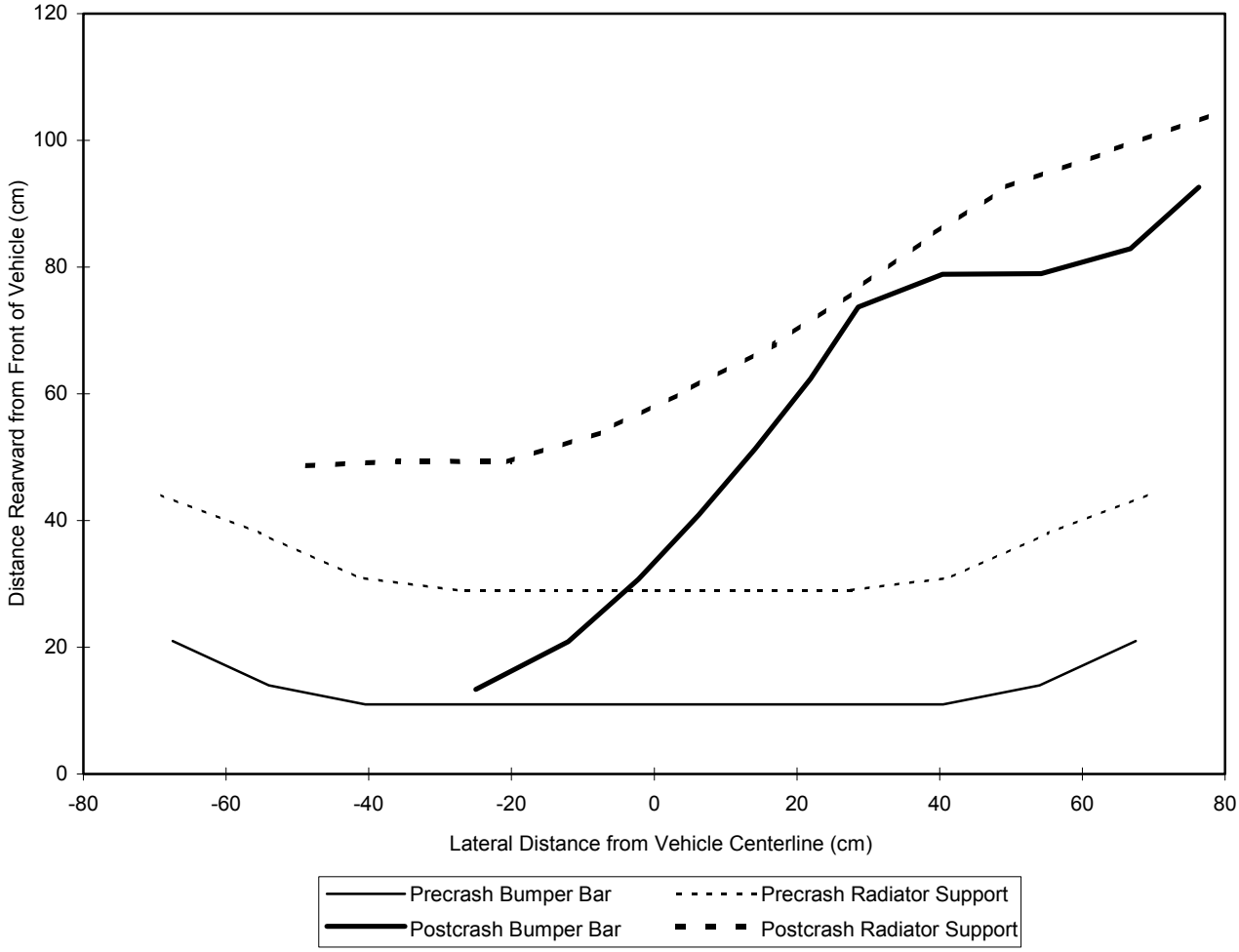

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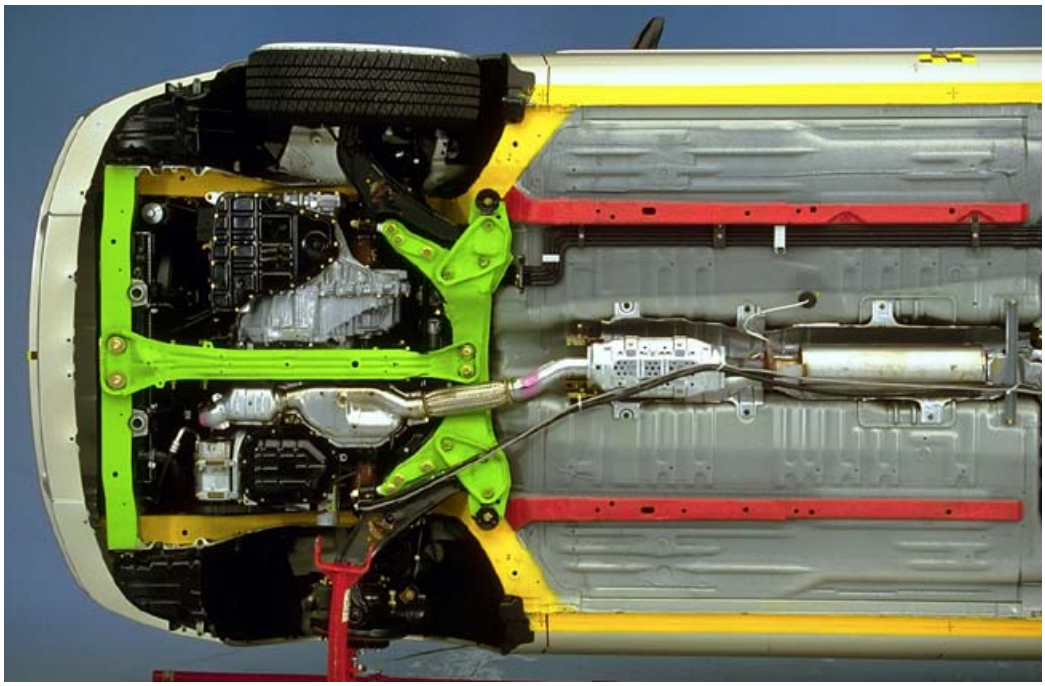
Figure 3
Precrash View from Below — 1998 Nissan Maxima



Postcrash View from Below — 1998 Nissan Maxima

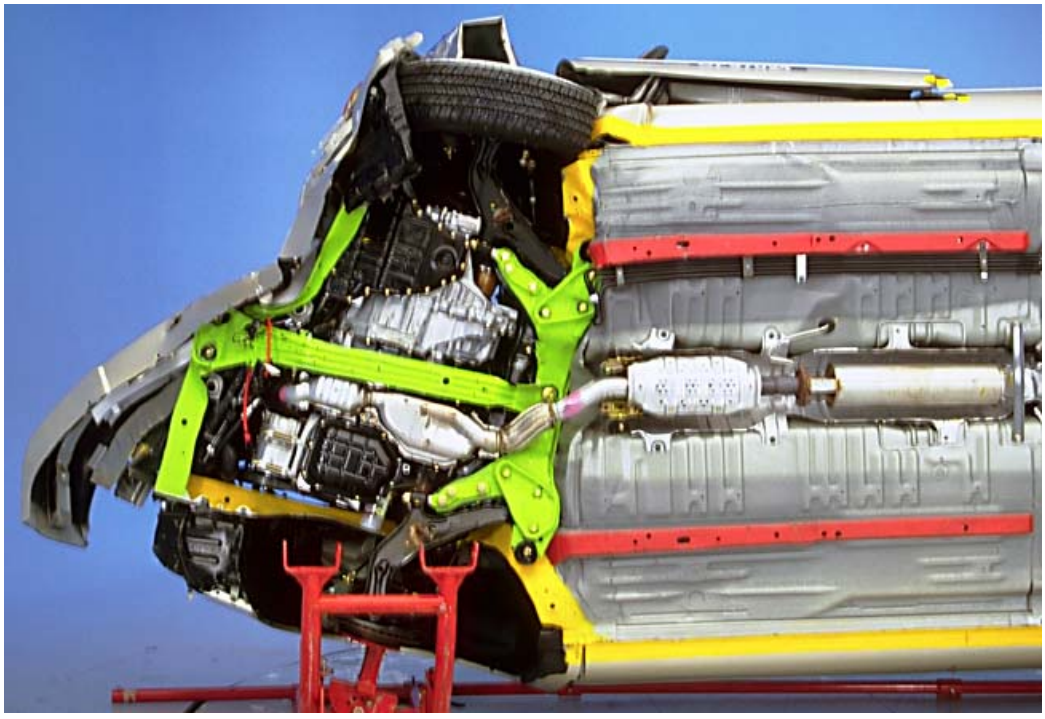


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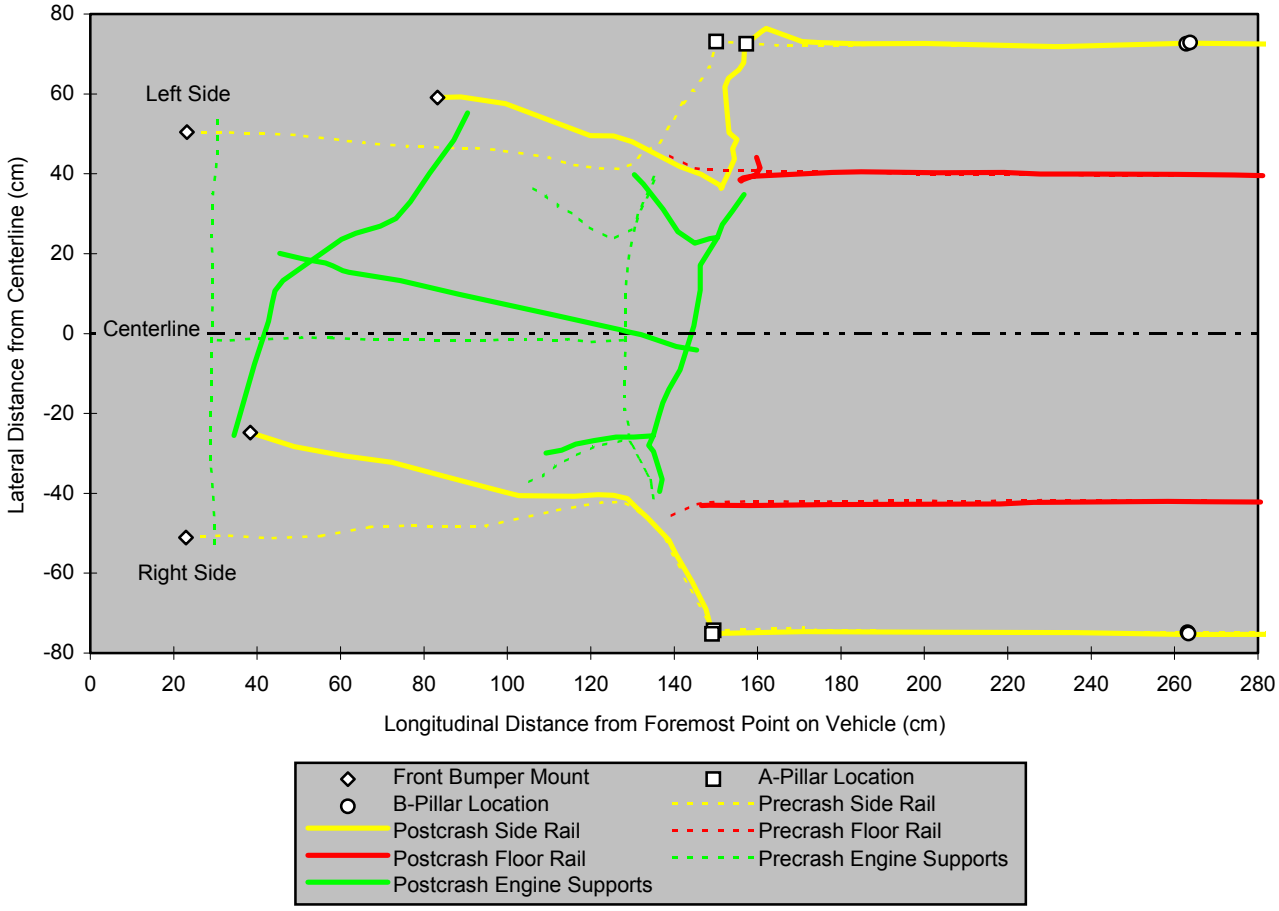
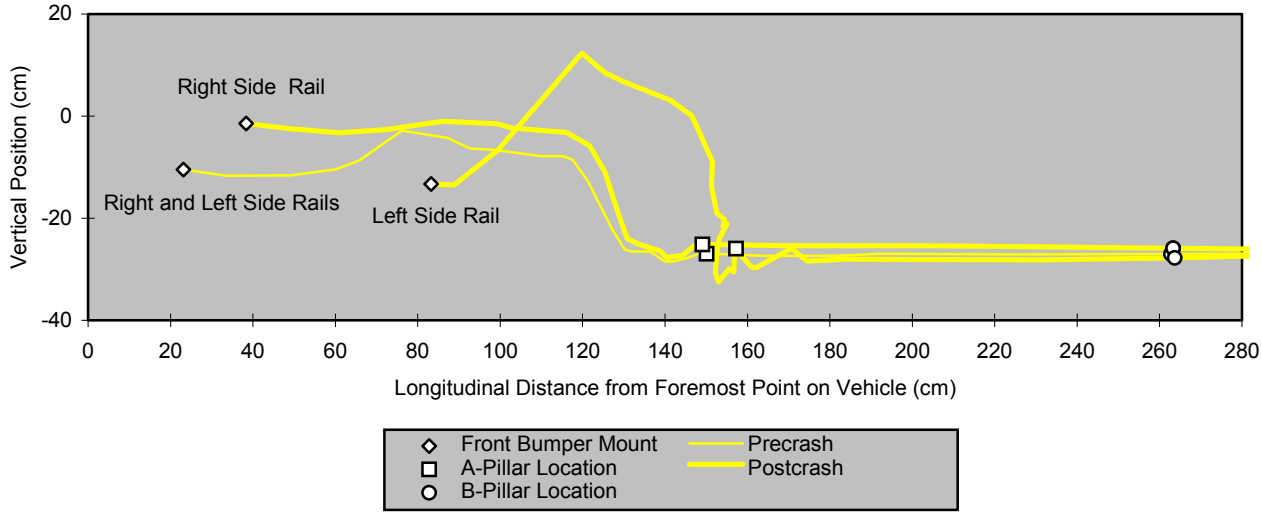
Figure 4
Frame Rail Deformation — 1998 Nissan Maxima

a) View from Below



b) Side View



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Various measures of intrusion were made after the crash. These residual measures of intrusion typically are less than the maximum deformation that occurs during the crash. The primary coordinate reference system for these measures is described in the IIHS Offset Barrier Crash Test Protocol (Version IV). The measures of deformation shown in Table 1 have been adjusted to better reflect the displacement of the various target locations relative to the driver. This was done by subtracting the average component displacements of the four seat-attachment bolts, which also were measured relative to the primary coordinate system, from the respective components of displacement for each of the target locations. The average displacement of the four seat-attachment bolts relative to the primary reference system also is shown in Table 1.

Table 1
Residual Measurements of Intrusion Relative to Driver Seat — 1998 Nissan Maxima

Selected Locations*	Longitudinal	Lateral	Vertical	Resultant
Steering column (cm)	-7	1	10	12
Left lower instrument panel (cm)	-10	0	4	10
Right lower instrument panel (cm)	-7	0	1	7
Brake pedal (cm)	-19	0	6	20
Left toepan (cm)	-29	-3	7	30
Center toepan (cm)	-27	-2	7	28
Right toepan (cm)	-21	-1	5	21
Footrest (cm)	-21	-2	4	22
Average displacement of the four seat-attachment bolts from primary reference system (cm)	-1	1	-3	—

* All measurements taken on driver side. From the driver's position, positive is forward, left, and up.

Restraint System Performance

Airbags

Driver: The uninflated driver airbag was 69 cm in diameter, and the excursion of its center when inflated was limited by four 29 cm-long tethers. The airbag was vented by two 40 mm-diameter holes at positions corresponding to 10 and 2 o'clock on the forward-facing surface of the airbag. Analysis of the high-speed film taken from camera position D indicates the airbag deployed at
20 ms into the crash and appeared to be fully inflated at 52 ms.

Passenger: The corner-mounted passenger airbag deployed at an angle and was untethered. The cylinder-shaped airbag was vented by two 28 mm-diameter holes located at the lateral ends. The airbag did not contribute to windshield damage during deployment.

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Seat Belts

This vehicle is equipped with dual-locking lap/shoulder belts with sliding latch plates at the outboard seating positions and adjustable upper anchorage points at both front seating positions. The front inboard lower anchorage points are attached to and move with the seats. The front outboard lower anchorage points are bolted to the floor. During the crash, 5 cm of webbing was pulled from the retractor through the D-ring as measured by a pull-string mounted between the retractor housing and the webbing just beyond the retractor.

Seat

Postcrash examination of the driver seat rails indicates no discernible movement of the seat in its tracks during the crash. Analysis of the high-speed film taken from camera position D indicates driver seat back movement was minimal. The driver seat tipped slightly outboard, but no significant floorpan deformation was visible.

Steering Column

The upper end of the steering column moved upward 10 cm and rearward 7 cm relative to the driver seat. The lower portion of the steering column inside the occupant compartment uses a tube-in-tube design, and a residual collapse of approximately 9 cm was measured. The upper portion of the column does not have shear modules; instead, bolts mounted in elongated slots are used. Movement in the slots measured approximately zero on the left side and 1 cm on the right side of the steering column.

Dummy Kinematics

Head, Neck, and Torso

Analysis of the high-speed film taken from camera positions B and D indicates the dummy's head, neck, and shoulders loaded the fully inflated airbag at 66 ms into the crash (14 ms after the airbag was fully inflated) and then moved leftward and downward. The dummy's head turned slightly to face right before the dummy began to rebound rearward and upward. The back of the dummy's head appeared to contact both the uppermost belt anchorage hardware on the B-pillar and the head restraint from 278 to 284 ms. This contact was confirmed by a paint transfer, and head acceleration data indicate the contact occurred at 279 ms. The dummy continued slightly upward and rearward and then settled back into the seat. Table 2 provides the timing and duration of these events.

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Table 2 Restraint System Performance and Dummy Kinematics — 1998 Nissan Maxima	
Event	**Time (ms)**
Deployment of airbag	20
Airbag fully inflated	52
Head begins to load airbag	66
Head contacts belt anchorage and head restraint	279

Legs and Feet

Left leg and foot: Paint transferred from the dummy's left knee indicates the knee contacted the instrument panel just above the knee bolster and to the left of the steering column, approximately 4 cm above and 4 cm to the left of the left instrument panel intrusion reference point. Paint transferred from the dummy's left shin indicates the top of the shin contacted the knee bolster approximately 4 cm below and 3 cm to the right of the left instrument panel intrusion reference point. The left foot was found fully dorsiflexed and slightly everted. The back of the heel was pressed against the floorpan, and the ball of the sole was against the intruding toepan, with the toes pointing almost vertical and slightly to the right.

Right leg and foot: Paint transferred from the dummy's right knee indicates the inside of the knee contacted the lower right corner of the steering column trim below the ignition switch, dislodging the plastic panel around the switch. The lower left corner of the knee transferred small amounts of paint to three locations: the top of the bolster under the right side of the steering column trim and the upper and lower inboard edges of the instrument panel padding below the instrument cluster. Paint transferred from the dummy's right shin indicates the shin also contacted the upper and lower inboard edges of the instrument panel padding, overlapping the paint from the right knee. The shin also contacted the knee bolster below the lower right corner of the steering column as well as the flat area of the bolster to the right of this point. The right foot was found fully dorsiflexed with the base of its heel against the intruded toepan and the back of its heel resting on the upward buckle of the floormat. The right foot was neither everted nor inverted. The right edge of the sole was resting against the center console trim, and the center portion of the bottom of the sole was against the lower edge of the accelerator pedal.

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Dummy Injury Measures

Head

The maximum vector resultant head accelerations were recorded and the HICs were calculated during an interval that corresponds with the dummy's head excursion into the airbag. Peak resultant head accelerations of 45 g, 19 g, and 16 g, respectively, were recorded at approximately 13 ms intervals after the maximum value was recorded (58 g at 100 ms). Postcrash examination of the dummy's nodding joint determined it to be loose, so the peak values might be attributable to this condition. The dummy's head contact against the uppermost belt anchorage on the B-pillar produced a peak resultant head acceleration of 28g at 284 ms. Table 3 provides a summary of the maximum head injury measurements recorded during the crash.

Table 3
Head Injury Measurements — 1998 Nissan Maxima

Measure	Published Tolerance Threshold	Result	Time (ms)
Vector resultant acceleration (g)	80	58	100
Vector resultant acceleration — 3 ms clip (g)	80	57	98-101
Head Injury Criterion (HIC)	1000	474	82-117
Head Injury Criterion — 15 ms interval (HIC-15)*	700	309	92-107

* A proposed amendment to the Canadian Motor Vehicle Safety Regulations suggests calculating HIC during a 15 ms interval rather than the 36 ms interval specified by the U.S. standard. The Canadian proposal includes an injury threshold of 700 for front-seat occupants protected by airbags.

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Neck

Table 4 provides a summary of the maximum neck injury measurements recorded during the crash.

Table 4
Neck Injury Measurements — 1998 Nissan Maxima

Measure	Published Tolerance Threshold	Result	Time (ms)
A-P shear force (kN)	±3.1*	0.4	186
Axial compression force (kN)	4.0*	0.5	286
Axial tension force (kN)	3.3*	1.6	113
Flexion bending moment (Nm)	190**	19	194
Extension bending moment (Nm)	57**	31	293

* These values are for instantaneous loading. Neck loads are compared with magnitude-duration injury criteria in Figures A-12 to A-15.

** These published thresholds are recommended injury assessment reference values from Backaitis and Mertz (1994), but significant neck injury may occur at lower bending moments. Mertz and Patrick (1971) report that bending moments of 47 Nm in extension and 88 Nm in flexion would be non-injurious for occupants represented by the Hybrid III 50th percentile adult male dummy.

Chest

Table 5 provides a summary of the maximum chest injury measurements recorded during the crash.

Table 5
Chest Injury Measurements — 1998 Nissan Maxima

Measure	Published Tolerance Threshold	Result	Time (ms)
Vector resultant spine acceleration — 3 ms clip (g)	60	43	96-99
Rib compression (mm)	50	30	95
Viscous criterion (m/s)	1.0	0.2	88

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Legs and Feet

Left leg and foot: The left lower tibia had a maximum resultant bending moment of 234 Nm at 85 ms, which contributed to a maximum tibia index of 1.08 recorded at the same time.

Right leg and foot: The right leg had a maximum lower tibia axial force of 4.5 kN and a maximum tibia-femur displacement of 13 mm.

Table 6 provides a summary of the maximum leg and foot injury measurements recorded during the crash.

Table 6
Leg and Foot Measurements — 1998 Nissan Maxima

Measure	Published Tolerance Threshold	Left	Time (ms)	Right	Time (ms)
Axial femur force (kN)	9.1*	3.4	94	2.9	75
Tibia-femur displacement (mm)	15	6	106	13	79
Upper Tibia					
L-M moment (Nm)	±225	43	101	-137	98
A-P moment (Nm)	±225	-82	101	-129	78
Vector resultant moment (Nm)	225	92	101	137	98
Index	1.00	0.41	101	0.66	78
Lower Tibia					
L-M moment (Nm)	±225**	-40	80	93	72
A-P moment (Nm)	±225**	232	85	75	77
Vector resultant moment (Nm)	225**	234	85	113	72
Axial force (kN)	8.0**	1.6	83	4.5	71
Index	1.00	1.08	85	0.62	72
Foot					
A-P foot acceleration (g)	±150	-33	81	-48	57
I-S foot acceleration (g)	±150	58	79	72	70
Vector resultant foot acceleration (g)	150	62	79	73	70

* This critical value is for instantaneous loading. Femur loads are compared with magnitude-duration injury criteria in Figures A-23 and A-34.

** These published thresholds are for fractures of the tibia. Ankle and foot injuries have been associated with bending moments as low as 50-100 Nm, and heel fractures have been associated with axial forces as low as 6.0 kN.

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Appendix

Dummy Clearance Measurements

Graph Index — index to graphs of time plots of dummy and vehicle data

Manufacturer's window sticker

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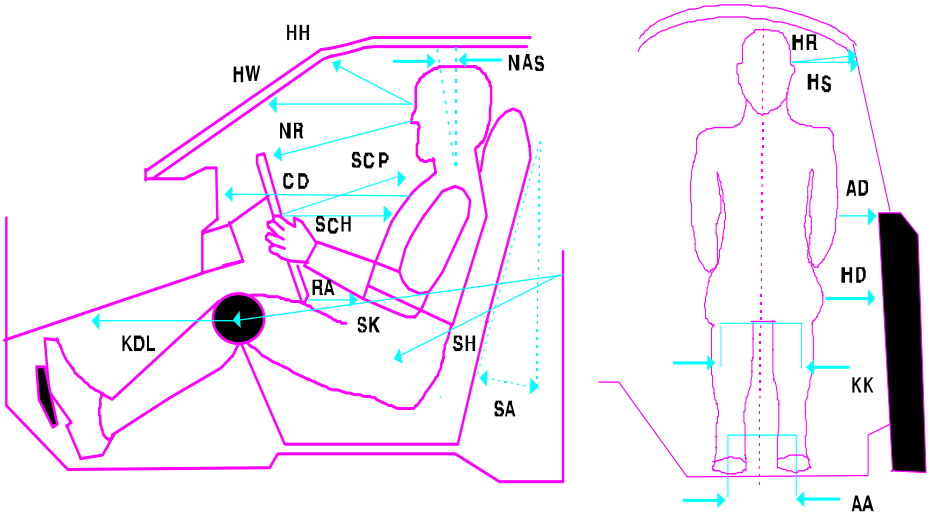
Dummy Clearance Measurements

Test Number: CF97024
Vehicle Make: Nissan Maxima
Vehicle Model Year: 1998
Seat Type: Electrical adjustment (fore/aft, height, and seat back tilt)

Manufacturer's Specifications
Seat Back Information: Set to 36.8 cm from center of left head restraint post to center of uppermost point of instrument panel
Upper Belt Anchorage: Set to uppermost position
Steering Column Adjustment: Set to midway between uppermost and lowest positions

Location	Code	Measurement	Location	Code	Measurement
Head to header	HH	280	Neck angle, torso 90	NAT90	28.7°
Head to windshield	HW	550	Neck angle, seated	NAS	8.1°
Nose to rim	NR	415	Torso angle (NAT90 – NAS)	TA	20.6°
Chest to dash	CD	670	Striker to knee*	SK	640
Rim to abdomen	RA	215	Striker to knee angle*	SKA	3.4°
Knee to dash, left	KDL	250	Striker to H-point, horizontal	SHH	243
Knee to dash, right	KDR	230	Striker to H-point, vertical	SHV	130
Steering wheel to chest, horizontal	SCH	310	Ankle to ankle	AA	310
Steering wheel to chest, perpendicular	SCP	395	Knee to knee	KK	300
Steering wheel to chest, reference	SCR	385	Arm to door	AD	105
Hub to chest, minimum	HCM	265	H-point to door	HD	150
Pelvic angle	PA	24.7°	Head to A-pillar	HA	495
Seat back angle	SA	16°	Head to roof	HR	200
			Head to side window	HS	245

All distance measurements are in mm.
* These measurements are made in a vertical plane containing the striker and parallel to the driver door sill.



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Graph Index

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