3.1.3.4 Thermal Shock

The switch shall resist cracking and delamination of surfaces, cracking and crazing of encapsulated compounds, opening of case seams, or changes in electrical or mechanical characteristics due to component displacement or rupture, upon completion of 10 thermal shock cycles per Section 8.5 of GM 9110P (-40°C to maximum operating temperature).

All components must withstand 10 cycles through the following thermal schedule:

1. Soak components at -40C (-40F) for 1 hour.
2. Remove components from chamber and allow to warm at room temperature for 4 minutes. Samples should be energized during warm-up.
3. Soak components at 85C (185F) for 1 hour. Samples should be energized during this period.
4. Remove components from chamber and allow to cool at room temperature for 2 minutes before soaking at -40C (-40F).
5. Samples must meet all functional requirements after frost has formed by removal from -40C.

3.1.3.5 Corrosion (Salt Fog)

The switch shall meet all performance test requirements during and after exposure to a corrosive environment consisting of salt spray, salt fog, and humidity. Switches shall be exposed to 96 hours of a salt fog test of a 5% salt solution at 35°C as tested according to Section 8.3 of GM 9110P.

3.1.3.6 Fluid Compatibility

The switch shall be able to withstand exposure to the fluids listed below.

Part must with stand contact with the following fluids with no degradation of performance, appearance, materials, sealants or identification.

Passenger Compartment:

Coffee	Alcohol Base Cleaner -10% by volume
Lubricating Oil (WD40)	Cola
Hand Cleaner	Lock-Ease Graphite/Oil
Soapy Water - 10% concentration	Vinyl Plasticizer
Salt Water - 5% saline solution	Ammonia Base Cleaner - 10% by volume
Silicon Hand Lotion	

The part shall be fixtured in a representative vehicle orientation, in the OFF detent, key-out, with applicable power and ground circuits connected. Two hundred milliliters of the test liquid shall be poured on the part from a height of 76 mm. Part should be allowed to set for a period of 24 hours while holding temperature at 21°C (70°F) to 29°C (85°F) without being wiped. Wash with water or wipe any remaining fluid from the part before applying the sequential fluid application. Use a minimum of 2X optical powered device to examine parts for degradation.

3.1.3.7 Dust Exposure

The switch shall meet all performance test requirements after exposure to 8 hours of dust exposure per Section 8.1 of GM 9110P.

3.1.3.8 Flammability Requirements

The materials used in the switch shall comply with GM6090M - Flammability of Materials.

3.1.3.9 Xenon Weatherometer

Not Applicable.

3.1.3.10 Altitude

Not Applicable.

3.1.3.11 Ozone

The switch shall meet all performance test requirements after exposure to ozone as tested per GM4486P. (Applicable to switches containing silicone-based materials only.)

3.1.3.12 Salt Water Immersion

Not Applicable.

3.1.3.13 Mixed Flowing Gas

For low current (<100mA) applications, the switch shall perform as specified when tested according to Section 15 of GM 9605P. The switches shall be able to withstand an environmental severity level of the engine/passenger compartment (class II) for a duration equivalent to 10 years of exposure. Time of exposure is (TBD).

3.1.3.14 Temperature Endurance Tests

Switches that contain electronic devices require special testing to verify switch capability of surviving stresses caused by extended exposure to temperature extremes. (Sections 3.1.3.14 1, 3.1.3.14.2 and 3.1.3.14.3 are provided for switches which contain electronics).

3.1.3.14.1 High Temperature Endurance

The switch shall perform as specified when tested according to Section 9.5 of GM9123P.

3.1.3.14.2 Low Temperature Endurance Test

The switch shall perform as specified when tested according to Section 9.6 of GM9123P.

3.1.3.14.3 Power Temperature Cycling

The switch shall perform as specified when tested according to Section 9.1 of GM9123P.

3.1.4 Interfaces

3.1.4.1 Electrical Interface

Pinouts shall be specified on the released product drawing. Pinouts cannot be changed without written authorization of GM Engineering.

3.1.4.2 Mechanical Interface

3.1.4.2.1 Column Lock Housing Interface

The ignition switch shall attach to the column housing as specified in the component part drawings.

3.1.4.2.2 Actuator Interface

The ignition switch shall interface with an actuator as specified in the component part drawings.
The actuator shall transfer forces from the ignition cylinder to rotate the switch contact mechanism during normal operation, and shall interact with the switch's theft deterrence mechanism to destroy the theft resistor during a slam-pull of the ignition cylinder or attempted removal of the switch in the OFF state.
In addition, the ignition switch shall utilize the linear motion of the actuator's key-in plunger to toggle an integral key-in switch.

3.1.4.3 Wiring Interface

Vehicle application wire gage size is determined by circuit protection and application load. For test purposes the wire gage size shall be 22 AWG.

3.1.4.4 Connector Interface

The ignition switch shall attach to the column wiring harness through a Packard Electric connector. The specific connector shall be specified in the component release drawing.
Connection interfaces shall comply with USCAR/EWCAP PF-1, Standard for Automotive Electrical Connection Systems.

3.1.5 Usage Definition

3.1.5.1 Target Life

GM has estimated the following profile for customer usage of the switch based on ten year exposure.

SWITCH FUNCTION	CYCLES
Ignition Switch	50,000

3.1.5.2 Duty Cycle

For purposes of durability testing, the switch duty cycle is defined as follows:

Step	Position	Dwell Time
1, Actuate Key-In switch	Off	>.5 sec.
2	Run	>.5 sec.
3	Start	1 sec.
4	Free Return to Run	>1 sec.
5	Off	1 sec.
6	Off	Deactivate Key-In for 1 sec.
Every 3rd cycle	Accessory	1 sec, return to "Off"

3.1.5.3 Actuation Rate

SWITCH FUNCTION	ACTUATION RATE
Ignition Switch Mode	6 cycles per minute
Ignition Switch Key-In	15 mm/sec.

3.2 PRODUCT CHARACTERISTICS

The required physical characteristics for the switch are specified in the following paragraphs.

3.2.1 Electrical Performance Requirement

Delta – Z SWITCH ELECTRICAL PARAMETERS

Circuit Identification		Signal Level (typ.)	Relay Level (typ.)	Key-In
Switch Temperature Rating		-40°C to +85°C		
Current Rating		30 µA - 3 mA	3 mA - 2 A	30 µA - 3 mA
	Duty Cycle	CONT	CONT	CONT
Rate of Actuation[1]	Minimum	50°/sec	50°/sec	1 mm/sec
	Maximum	1500°/sec	1500°/sec	20 mm/sec
Wire Size (mm^2)		0.35	0.35	0.35
Voltage Drop (max.)			350 mV	
Contact Resistance (max.)		100mΩ		100mΩ
Open circuit Resistance (min)[2]		20 Meg-Ohm	20 Meg-Ohm	20 Meg-Ohm
Temperature Rise		50°C		
Contact Bounce	% O.C.V.	10	10	10
Maximum Duration	Individual	1 ms	1 ms	1 ms
	Total	10 ms	10 ms	10 ms
	No. Bounces	5 max	5 max	5 max
Durability Equipment	Rate	100± 1°/s	100± 1°/s	15 ± 1 mm/s
	Level	2 Nm	2 Nm	4 N

1. Min-Max rates of actuation are based on timing requirements
2. 1 M-Ohm min @ 24V at conclusion of testing
3. Each circuit shall be capable of handling both min and max currents during validation testing.

GMX 320 – Switch Electrical Parameters

Circuit Identification		Signal Level (typ.)	Relay Level (typ.)	Key-In N/A
Switch Temperature Rating		-40°C to +85°C		
Current Rating		30 µA - 3 mA	3 mA - 2 A	
	Duty Cycle	CONT	CONT	
Rate of Actuation[1]	Minimum	50°/sec	50°/sec	
	Maximum	1500°/sec	1500°/sec	
Wire Size (mm^2)		0.35	0.35	
Voltage Drop (max.)			250 mV	
Contact Resistance (max.)		100mΩ		
Open circuit Resistance (min)[2]		20 Meg-Ohm	20 Meg-Ohm	
Temperature Rise		50°C		
Contact Bounce	% O.C.V.	10	10	
Maximum Duration	Individual	1 ms	1 ms	
	Total	10 ms	10 ms	
	No. Bounces	5 max	5 max	
Durability Equipment	Rate	100± 1°/s	100± 1°/s	
	Level	2 Nm	2 Nm	

3.2.1.1 Operating/Test Voltage

The switch shall function as specified in this document without interruption within the operating voltage range of 9.0 - 16.0 Volts dc (for high/low current applications when operated at ignition or battery voltage) and 5 ± 0.1 Volts dc (for low current, regulated voltage applications).

The switch shall be tested at a nominal voltage rating of 14.0 ± 0.1 V dc for 12 V circuits and 5 ± 0.1 V dc for 5 V circuits.

3.2.1.2 Applied Loads (Current)

The switch shall be capable of performing functions defined in Section 3.1 of this document when used to control the electrical loads specified.

3.2.1.3 Voltage Drop

Voltage drop on all low current switches (>3.0 mA, < 2.0 A) is not to exceed 350 mV at the rated current when tested according to Section 5.1 of GM 9110P.

3.2.1.4 Contact Resistance

Contact resistance on all logic level switches (< 3.0 mA) is not to exceed 100 mOhms at the rated current.

3.2.1.5 Open Circuit Resistance

The open circuit resistance of all circuits shall be greater than 20 MΩ when tested according to Section 5.2 of GM 9110P.

3.2.1.6 Isolation Resistance

The isolation resistance of all circuits shall be greater than 20 MΩ when tested according to Section 5.3 of GM 9110P.

3.2.1.7 Continuous Current Overload

The switch shall conform to the maximum current requirements when tested according to Section 7.4 of GM 9110P.

3.2.1.7.1 Short Circuit Requirement

The switch must be able to sustain a short circuit condition as tested below. A test to verify that circuit protection is adequate is as follows:

Use a power supply with a minimum steady state capability of 20 Amps and an automotive lead acid battery in parallel. Use a 0.35 mm^2 wire with length to provide less than 20 milliohms of resistance. Use a series fuse rated at 10 Amps unless otherwise specified. Apply power at 14.0 V DC per design pinout. Battery circuits are exempt from shorts to ground. Follow the procedure below:

1. Test with the ignition switch in the 'RUN' position for all contacts, with the exception of the key-in contact, which shall be tested in the 'OFF' position with key-in simulated. The 'START' circuit contact (through the theft resistor, R2) is exempt from this test.
2. Short circuits to ground through a 1.4 ohm resistance, one circuit at a time.
3. Apply shorts for one hour or until unit fails.
4. Record results. Measure actual current flow and time duration. Indicate if fuse blows, and any other visual results of the test.
5. Repeat steps 1 through 3 using a 1.0 ohm resistance, and a direct short circuit to ground.
6. Disassemble switches and record results of visual inspection.

General Motors shall review all test results and samples for approval.

3.2.1.8 Contact Bounce

No individual bounce shall exceed 1.0 msec in duration. There shall be no more than 5 contact bounces. A contact bounce shall not occur 10 msec after the initial make or break. For analysis purposes, the contact bounce duration shall be defined as the time periods when the voltage across the contacts exceeds 10% OCV (Open Circuit Voltage) for Normally Open contacts and 90% OCV for Normally Closed contacts. Contact bounce shall be measured at the rated electrical loads using an oscilloscope as specified in Section 5.12 of GM 9110P.

3.2.1.9 Electro-Magnetic Compatibility (EMC)

The switches shall meet any applicable EMC requirements set in GM 9100P series. In particular, the device shall meet the performance objectives of GM9105P, Immunity to Conducted Transients, and GM9109P, Immunity to Electrostatic Discharge, for a Class C device. (This requirement is applicable only to products with discrete electronic components.)

3.2.1.10 Reverse Polarity

The switch shall operate without damage or performance degradation when tested according to Section 7.2 of GM 9110P

3.2.1.11 24-Volt Jump Start

The switch shall operate without damage or functional degradation when tested according to Section 7.3 of GM 9110P.

3.2.1.12 1000 Hour Load Soak Test

The switch must meet performance requirements after exposure to 1000 hours continuous duty when tested according to Section 9.10 of GM9110P.

3.2.2 Physical/Mechanical Requirements

3.2.2.1 Dimensions and Capacities

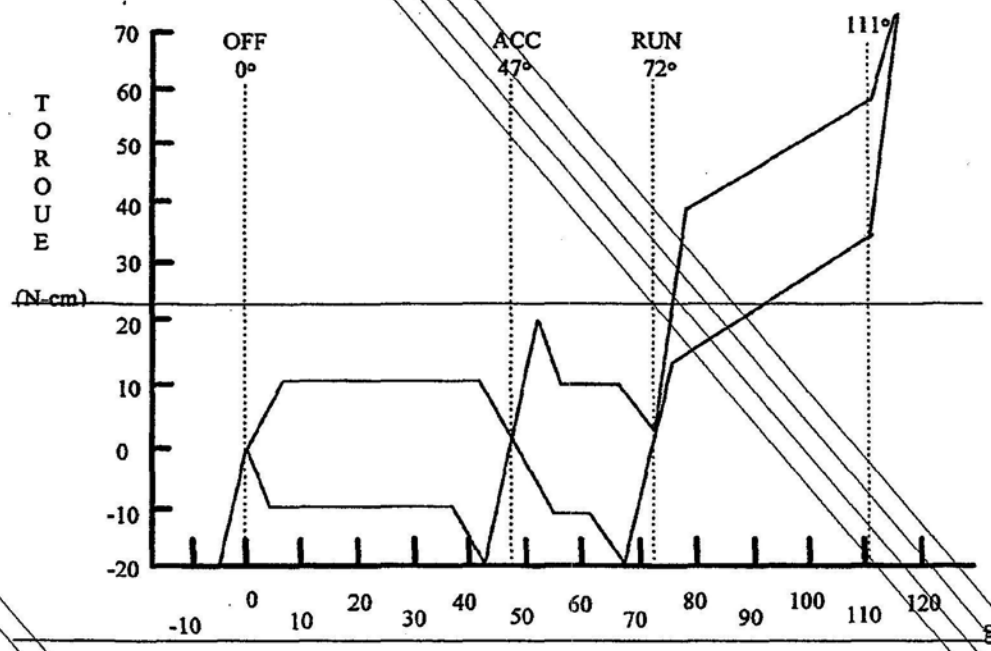
Dimensional requirements shall be specified in the component part drawing.

3.2.2.2 Mass Properties

Mass of the switch shall not exceed 150 grams.

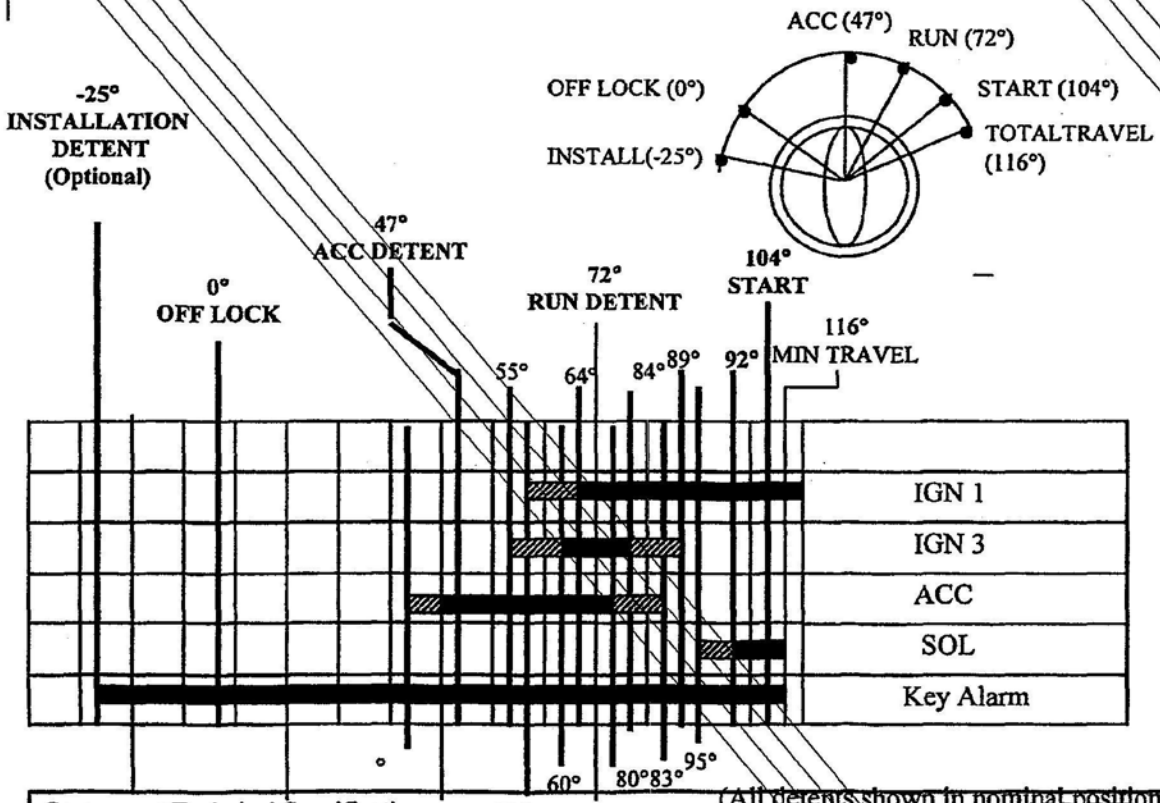
3.2.2.3 Tactile Characteristics

Refer to the Force Displacement Curve(s). Final switch tactile feel is subject to GM Engineering approval. Switch efforts shall be smooth with clearly defined detents. The switch shall not be damaged when the maximum allowable torque is applied to the actuator, clockwise or counterclockwise. All functionally detented switches must operate without noticeable friction or binding.
The supplier shall maintain GM approved master samples for comparison throughout the life of the program.



gineering approval.

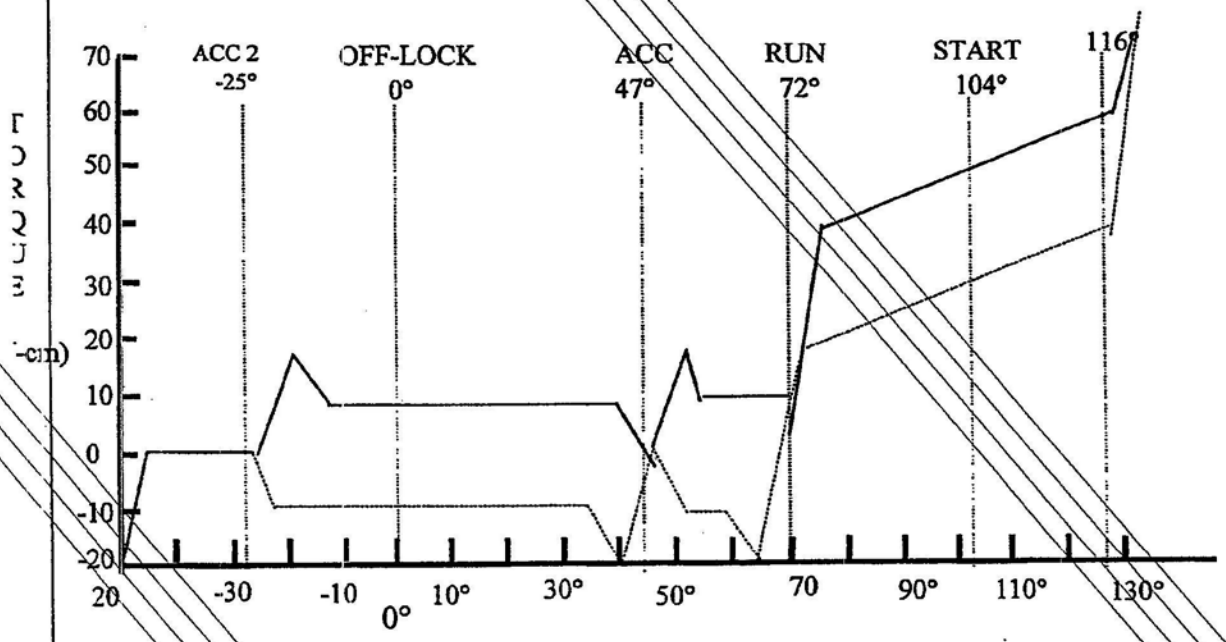
FIGURE B: SWITCH TRAVEL REQUIREMENTS



Notes:

1. IGN3 MUST MAKE A MAXIMUM OF 10° AND A MINIMUM OF 2° PRIOR TO IGN1 MAKING GOING FROM OFF TO RUN.

TORQUE vs. ROTATION



DISPLACEMENT (Degrees)

IGNITION SYSTEM TORQUE REQUIREMENTS

Actual curve to be furnished by supplier after GM Engineering approval.

Column Torque Requirement:
The maximum allowable torque of the Lock Housing/ Key Lock Cylinder interface (excluding the ignition switch) MUST not exceed 10 N-cm.

Ignition Switch Torque Requirement:
The minimum torque required by the switch, on the return side of the ignition switch from CRANK to the RUN position MUST be 15 N-cm.

NOTE:

Torque Curve allowable tolerance shall not exceed +/- 5 N - cm.

3.2.2.4 Sound/Audible Requirements

The switch shall produce no more than an average audible sound of 50 dBA over 250 ms in the 20 Hz to 20 KHz range when tested at a distance of 900mm according to the procedure specified in Section 5.11 of GM 9110P.

3.2.2.5 Rattle

The switch shall not rattle, squeak, or make any undesirable noise as tested per Section 5.15 of GM 9110P. Six switches that have completed the 3 times life cycle testing must be submitted to NAO engineering to demonstrate compliance to this requirement.

3.2.2.6 Mechanical Drop

The switch shall withstand a 1 meter drop onto a concrete surface in three mutually perpendicular axes without loss of function when tested as specified in Section 7.5 of GM 9110P.

3.2.2.7 Mechanical Shock

The switch shall meet the electrical and mechanical requirements when subjected to 3 shock pulses in both the positive and negative directions in each of three mutually perpendicular axes (a total of 18 pulses) as specified in Section 7.6 of GM 9110P. Nuisance contact openings shall be of less than 1.0 ms duration.

3.2.2.8 Terminal Retention

Each terminal shall not sustain permanent deflection exceeding 0.1 mm or functional damage when subjected to a 50 N force as specified in Section 6.2 of GM 9110P. Each terminal shall also withstand an axial pull out force of 25 N. Apply force at a rate of 50 ± 10 mm/minute.

3.2.2.9 Connector Insertion

The maximum force required for connector insertion shall not exceed 80 N when tested according to Section 6.3 of GM 9110P.

3.2.2.10 Connector Retention

The connector and switch shall withstand a 75 N pull to the harness in a 360° arc perpendicular to the connector axis as well as a 150 N pull normal to the connector without pulling loose or effecting the electrical function. A simulated vehicle harness with a maximum length of 200 mm and all locking features engaged shall be used for test purposes.

3.2.2.11 Switch Case Integrity

The switch shall conform to the following switch case integrity requirements when tested as specified in Section 6.4 of GM 9110P.

Minimum Case to Base Retention Force (Pull)	110N
Minimum Case Strength Force (Push)	110N

3.2.2.12 Switch Retention and Insertion

The switch shall be installed with two screws. The switch shall be retained during the application of 220N in the direction to remove the switch from a representative column head. Apply the load perpendicular and in the center of the switch.

Note: Apply force at a rate of 50 ± 10mm/minute.

3.2.2.13 Mechanical Overload

The switch actuator shall be capable of withstanding, with no structural or functional damage (no permanent deformation that exceeds the released print tolerance, and shall have no separation or loosening of the components or switch), the following forces when tested as specified in Section 6.5 of GM 9110P.

Push-Key In	110 N
Push-Theft Deterrence Mechanism	220 N
Torsional-Key Rotation (Against Stops)	4 N-m

3.2.2.14 Switch Surface Temperature

For non-touchable surfaces, the maximum temperature rise shall not exceed 50°C at rated load (ref. section 5.5 of GM9604P) when tested in a representative vehicle location and orientation.

3.2.2.15 Theft Deterrence

The integral theft resistor shall be destroyed (damaged beyond value determination) during a slam-pull of the switch actuator or attempted removal of the switch from the ignition cylinder housing with the switch and actuator in the OFF orientation.

Compliance to this requirement shall be demonstrated by the following:

1. Mount each ignition switch in a representative column housing with the correct cam/actuator interface. Place the switches and actuators in the OFF position.
2. Six samples shall be subjected to a force applied to the switch actuator, along its axis in the direction of key/cylinder removal, for a distance of 5.0 mm. The maximum applied force shall be between 40 N and 300 N.
3. An additional six samples, with mounting screws removed, shall be subjected to a force capable of separating each switch from the column housing a minimum distance sufficient to rotate the switch to its RUN position. Apply the force at the center of the switch housing and normal to its mounting plane.
4. Disassemble each switch without further disturbing the switch internals. Each theft resistor shall be damaged beyond visual or measured determination of its value. All samples shall be submitted to GM Engineering for review and approval following this test.

The ignition switch shall be protected from determination of the theft resistor value (with the switch in the OFF position) through tamper of the switch utilizing commonly available tools (hammer, screwdriver, ohmmeter, etc.). Six switch samples shall be submitted to GM Engineering to validate compliance to this requirement.

3.2.3 Dependability

3.2.3.1 Target Life

Refer to Section 3.1.5.1 in this document for switch cycle definition.

3.2.3.2 Reliability Requirements

The switch shall demonstrate a reliability of 98% at one life with 50% confidence. The supplier is responsible for initial and ongoing failure rate verification of the switch.

3.2.3.2.1 Reliability Testing/Demonstration

Twelve switch samples (from durability testing) shall continue to test to 3 times life without failure with the same temperature profile as specified in Section 3.1.3.1. Performance parameters shall be measured at 150%, 200%, 250%, and 300% of the test. If a failure occurs before 3 times life, continue testing until five samples fail with the same failure mode. Perform a Weibull Analysis and determine the B2 life. If the B2 life is greater than 1 times life, the test samples may be approved by Engineering. All failed switches shall be analyzed for root cause of failure.

3.2.3.2.2 Reliability Calculation

Median Rank Approximation shall be used to calculated the reliability of the ignition switch. The Weibull analysis data shall include the following:

- Minimum Life,
- Slope,
- Characteristic Life,
- 50% Confidence Interval, and
- Reliability at the end of one life.

3.2.4 Serviceability

Parts must be serviceable with commonly available tools The ignition switch shall be serviceable without damage to the theft resistor with the ignition key/cylinder oriented in the RUN position.

3.3 DESIGN and CONSTRUCTION

3.3.1 Identification and Marking (Component Labeling)

An eight digit part number is to be clearly marked on each separate part. The pin designator (number or letter) shall be marked near each terminal.

Theft resistor value shall not be identified (coded or otherwise) on any interior or exterior surface of the switch.

The Julian date code shall appear on each part only after successful completion of End-of-Line tests. (Refer to GM 9604P.) The first digit shall indicate the year of manufacture, the last three digits shall be the day of the year. For example, 7365 is 1987, December 31.

The manufacturer's identification shall appear on each part, including the line number, shift, and/or facility where duplication exists. The minimum height of the each character shall be 1.5 mm.

3.3.1.1 Marking of Plastic Parts

All plastic parts shall have a polymer identification symbol per SAE J1344 for recyclability purposes.

3.3.2 Interchangeability

The ignition switch shall be designed for maximum utilization of common components when multiple ignition switches are developed to enable cross-carline compatibility.