1 May 1969 – Article describing the first electronic cruise control for Ford vehicles by Fred W. Holder, a Bendix Engineer

2 1973 – William C. Follmer's article on Electronic Speed Control – pages 255 to 259

- The cruise control design that is the focus of the paper is, for all intents and purposes, the same as the Standalone and IVSC units.
- The most important of the "environmental factors of number one design importance" is "power supply level and transients". This shows that the components are very sensitive to high voltage, spikes, and EMI.
- Also discussed are the danger of negative transients and the use of Zener diodes to combat them.
- "It cannot be overemphasized that the environmental specifications are a major item in the logical design of any electronic system. The ability to survive in a given environment must be designed in, it cannot be added later on."

3 September 16, 1974 – "Printed wiring circuit guard ring" - #3937980

- Patent by: Aeronutronic Ford Corporation
- "reduces surface leakage between conductors on Printed Circuit Board"
- The invention could be used in a cruise control unit – "If the high impedance point were to develop uncontrolled leakage to a point of substantially different potential, **the speed control unit could malfunction to result in excessive accelerations of the vehicle**"

4 October 1975 – "Investigation of Electromagnetic Interference Effects on Motor Vehicle Electronic Control and Safety Devices"

- This document is the result of a study to investigate, identify, and analyze the potential problems of EMI that may cause malfunction of motor vehicles.
- Section 7.6 states: "The speed controller could be deactivated when the car is not moving… If the speed controller had a serious EMI problem when the car is not moving, deactivation of the circuit may be the least costly approach to solving the interference problem" (page 196) – this is the exact definition of the "lock-out switch" proposed by Sam Sero.
- This one paragraph, printed in 1975, effectively negates any of Ford's financial excuses for protecting against EMI in the speed control.
- This document contains warnings and recommendations regarding the growth of electronics in vehicles and the need for adequate EMI protection.

5 March 12, 1976 – "Safety vacuum valve and electric switch for speed control systems" - #4192399

- Patent by: Dana Corporation
- Popular brake pedal dump switch

6 February 22, 1977 – "Vehicle Speed Control with dual interrupt safety circuit" - #4120373

- Patent by: Robert Bosch GmbH
- "To prevent dangerous conditions from arising, and run-away of the engine in case of malfunction of the coupling, and electronic circuit is provided to introduce a signal to the speed control system which tends to move the throttle positioning motor to change the position of the throttle to idle speed condition if a disabling signal is sensed.

7 June 15, 1977 – "Speed responsive systems" - #4140202

- Patent by (and assignee): Associated Engineering Limited
- Includes a "control logic and safety circuit for rendering the system operative and inoperative has a memory cancel facility which cancels the previously memorized cruise speed stored in the

memory when a driver of the vehicle makes an action associated with bringing the vehicle into, or preparatory to driving the vehicle from, a parked condition."

8 January 9, 1978 – "Acceleration Warning Device" - #4171030
- Patent by: Hermann Ruhl, no assignee
- Includes a differentiating circuit "for indicating when the acceleration of the vehicle is beyond a predetermined rate"
- The system may also include control means for automatically limiting the acceleration of the vehicle

9 March 22, 1979 – "Vehicle Speed Control System" - #4352403
- Patent by: Travel Accessories Manufacturing Company

10 September 8, 1980 – "Safety Disengagement Device for automotive speed control system" - #4355607
- Patent by: Zemco Incorporated
- "a device for detecting accidental engine load removal and for providing disengagement of the speed control system **to prevent an engine runaway condition"**
- The output signal can either disable the speed control system or the ignition directly

11 January 15, 1981 – "Automatic Speed Control System for an automotive vehicle" - #4434469
- Patent by: Nissan Motor Company Limited

12 December 23, 1981 – "Engine Control Apparatus for Vehicle Speed Control" - #4472777
- Patent by Ford Motor Company
- "There is thus provided an additional safeguard against uncontrolled vehicle acceleration"
- "There are additional combinations of sensor outputs which enable one to detect a stuck throttle condition"

13 August 14, 1981 – Ford Corporate Engineering Design Standards – pages 5-6
- This document sets vague standards for Low Voltage Wiring in Ford's vehicles.
- This document specifies three engineering design categories:
  - Conductor Grouping
    - Discusses twisting of the conductors in sensitive circuits
  - Electromagnetic Compatibility Guidelines
    - Spacing of ignition components from susceptible devices
    - Spacing of starter motor cables
    - Isolation of wiring for high current devices
  - Outer covering
- These specifications eventually became a part of www.fordemc.com

14 January 22, 1982 – Ford Corporate Engineering Design Standards – page 12
- This document sets vague standards for Low Voltage Wiring in Ford's vehicles.
- Grounding
  - "Electronic devices shall be grounded at one location only and should not share a common ground return with noise producing subsystems or components"
- "Two wire or three wire systems shall be used for all A-C circuitry"
  - See August 14, 1981 Design Standards – for many operating frequencies, these wires must be twisted
- These specifications eventually became a part of www.fordemc.com

15 June 18, 1982 – “Automatic Disengagement device for Automotive Cruise Control System” - #4522280

- Patent by: Zemco Incorporated
- Three protection circuits offer triple redundancy

16 July 20, 1982 – “Fail-safe Speed Control System for Motor Vehicles” - #4539642

- Patent by: Nippondenso Company Limited
- A speed control actuator failure detector

17 October 18, 1983 – “Ignition current sensor for an electronic speed control system” - #4495913

- Patent by: Dana Corporation
- “An electronic circuit for disengaging an electronic speed control system when the rate of change of the automobile engine speed exceeds a predetermined amount”

18 1985 – Cruise control becomes standard equipment on Ford Panther platform vehicles. There was no option to uninstall cruise control (as per documents in Huber vs. Ford Motor Company)

19 June 7, 1985 – EMC/RFI Requirements/Considerations and their Complications on LIV (low investment vehicle) Bates numbers “1987 0942” through “1987 0947”

- This document outlines in detail “both the troublesome electromagnetic energy sources within the vehicle and the principal external electromagnetic sources from which the vehicle electronic components must be shielded.”
- The document “reviews Ford test practices and facilities, provides general design guidelines, and recommends steps to be taken on the LIV to assure EMC.”
- The references sited in this document stretch back to 1975 Ford test standards for RFI.

20 September 2, 1986 – Input circuit for an electronic vehicle speed control unit - #4608954 (see page 6 under Description)

- Patent by: Dana Corporation
- “Frequently, electronic control circuits are utilized to control the supply of vacuum to the bellows. However, such electronic control circuits are subject to unreliable operation or failure because of the large amount of electrical noise present in the vehicle engine. Such noise is typically generated by the vehicle ignition system and can adversely affect the signal representing the actual speed of the vehicle. Accordingly, it would be desirable to provide an input circuit for the electronic vehicle speed control unit which is resistant to such spurious noise signals.”

21 September 22, 1986 – Attachment I-C of a response by Ford to NHTSA’s request for any complaints of sudden acceleration. (Bates number “2049 0002”)

- Complaints listed are from Ford employees assigned company-owned vehicles for evaluation. At regular intervals, the employees are asked to fill out a review sheet and report any problems with the vehicles. Three complaints are admitted in this document:
- Ford Mustang 3.8L Engine – “At times, when we come to abruipt stop from around 45-55 mph, after braking action is complete, the car may surge forward and require immediate, additional braking action.”
- Mercury Grand Marquis 5.0L engine – “Tremendous surge when the park position was shifted to drive on one occasion for no apparent reason”
- Lincoln Continental 5.0L engine – “Starting-rapid run in engine speed almost lost in car wash”

22 October 21, 1986 – Ford Technical Affairs Committee Meeting Minutes (Bates numbers “TFIK 2373” through “TFIK 2400”)

- This document comes just short of an outright admission of guilt as far as Ford’s inability to properly design out or at least test for electromagnetic compatibility.
- Mentions that vehicle electric and electronic systems are becoming more and more complex, and therefore customer complaints that could not be resolved (aka Trouble Not Identified) have risen proportionally to this complexity.
- This document is literally chock-full of damning quotes, here are a select few:
  - “We have not done as good a job as we should on optimization of the electrical and electronic systems in vehicles and that we should identify and agree upon specific remedial actions”
  - “**Electromagnetic Influences** in the vehicle environment may induce a component’s performance to be unacceptable. When removed from the vehicle, the component will test good.”
  - “The President (presumably of the company) posed the fundamental questions as to **whether we were properly organized to deal with vehicle electronics** and whether we are adequately deploying systems engineers.”
  - Some of the key conclusions:
  - Lack of sufficient problem anticipation
  - Use of overly sensitive designs and processes
  - Lack of true systems engineering
  - No uniform procedures for circuit analysis
  - Lack of understanding in respect to causes of TNI field returns
  - Electrical Transients

23 1986-1987 – Ford’s Fault Tree Analysis (aka Ishikawa diagram)

- This document shows all root causes of possible malfunctions that can lead to Sudden Acceleration
- Electromagnetic Compatibility, Transients, and other Corrupt Inputs (such as an internal short with outputs grounded) can lead to an Internal EEC Fault that would cause Sudden Acceleration
- Total of six root causes shown in Ishikawa diagram:
  - Operator Error
  - Intake Vacuum Leak below throttle
  - Vehicle Speed Control System Mechanical Malfunction
  - Stuck Throttle
  - Mechanical Actuation not Initialized by Driver
  - Vehicle Speed Control System Electrical Malfunction
- When investigating for these six causes, a process of elimination is employed. Ford obviously knew about this diagram and the process of elimination because the questionnaire follows the process of elimination of these six causes with individual questions (see below).

24 1987 – Ford’s Updegrove study launched

- A Ford internal report to study the cause of the rising number of customer complaints of Sudden Acceleration.
- Although this study was begun by Ford in 1987, they never provided any data nor did they even inform the NHTSA about its existence while the NHTSA was compiling information for its own Sudden Acceleration study.
  - History
    - Pre-1988: Growing number of complaints with the introduction of a broadly applied electronic cruise control in 1984.
    - 1988-1990: The Thunderbird and Cougar (MN-12 platform) had disproportionally high numbers of complaints (IVSC – cruise control “brain” incorporated into the Powertrain Control Module). Having so many electronics operating so closely without proper circuit protection severely increases the risk of electromagnetic interference leading to undesirable operation. Ford’s solution was to add a brake-transmission shift interlock

        (BTSI). At the same time the BTSI was installed on the vehicles, the speed control's integrated design was changed to a standalone system where the speed control circuitry was moved out of the PCM and into its own housing. The numbers of complaints dropped, but there is no way to know if it was because the speed control circuitry was moved to a less harsh EMI environment or because the BTSI was introduced.
        - 1991-1992: Since number dropped, study was closed. The more responsible reaction should have been to continue study and continue to improve the vehicles' safety equipment until no complaints received. Also, Ford should have been very curious as to why all these people would make inconsistent complaints against them, especially in the cases where no damage was done to the vehicle. This should have been pursued by Ford, but it was not.
    - Investigation – focused on problems with individual cars, did not investigate problems associated with the actual design or engineering.
        - Total of 2877 cases
        - Investigated engine control electronics, underhood linkages, wiring and speed control, in three steps: engine off, idling, and on road at highway speeds
        - Included "evaluating" the electronics of the vehicle with an "EEC IV Intermittent Tester"
        - Interviews with the driver and any witnesses and questionnaire for driver (see below).
        - Overall, these tests did not look at cruise control operation or susceptibility of the electronics to electromagnetic interference; they were only a way to try to rule out anything but driver error.
    - Conclusions – cases were lumped into 6 categories
        - Misapplication – the Driver Error category
        - Normal – engine's idle control caused increase in engine speed
        - Hardware – floormats, throttle linkages, "engine control or speed control hardware issues"
        - Complete – interviews, allegations, and vehicle investigation results "are logical, but no explanation for the event can be determined"
        - Inconsistent – interviews, allegations, and vehicle investigation are not consistent with each other
        - Incomplete – facts unavailable, incomplete interview
    - The vast majority of complaints were put into the Inconsistent category, and less than 2% were put into Misapplication, Normal, and Hardware combined.
- As of January 1, 1993 all cases referred to FCSD District offices – this effectively ended the study

25 1987 – Ford's Updegrove study Questionnaire

- This is the questionnaire referred to as the Customer Interview in the Updegrove study, which follows the process of elimination using the Fault Tree Analysis causes. A technician, who then investigates the car, administers it.
- Below each category, questions that imply that category as a cause are listed. (Some of these questions have been paraphrased; every effort has been made to preserve the original wording.)
- Operator Error
    - "Handicapped Driver Aide?"
    - "During normal braking, does the customer typically pump brakes?"
    - "Which foot is typically used in normal braking maneuvers?"
    - "Ask the driver to describe the typical starting procedure they use with this vehicle"
    - "When the alleged event took place was it during a trip or sequence normally followed by the operator?"
    - "The operators age was estimated at?" (not asked for)
    - "During the interview, did the owner indicate a knowledge of the publicity on "sudden accelerations"?"
- Vacuum Leak
- "If brake was used to slow vehicle during the alleged event, the feel of the brake was?"

- "During the alleged event, did operator notice any noises he would suggest were not normal?" i.e. a vacuum leak (squeal)
- Install the EEC IV monitor with intermittent module and pressure sensing adaptor in the vacuum line between the speed control servo and the mechanical brake actuated vacuum dump valve.
- Brake performance test: "Will brakes hold against full throttle, from standstill? At 30mph?"
- "Inspect vacuum routings to insure conformance to calibration schematic, and that there are no pinched or crimped lines"
- "Check operation of mechanical brake actuated dump valve"
- Vehicle Speed Control System Mechanical Malfunction
    - "During the alleged condition was the speed control engaged? If so, at what speed?"
    - "Did control shut off with brake application or switch?"
    - "During the alleged event, did the operator perceive the accelerator pedal to move?"
    - "Test vehicle response to all modes of speed control"
- Stuck Throttle
- "During the alleged event, did the operator kick the accelerator pedal?" i.e. to try to unstick it
- Mechanical Actuation not Initialized by Driver
    - "OEM or Aftermarket Floormats?"
    - "Engine or Vehicle speed change during transmission engagement?"
    - Test engine response to accessory cycling, note any speed changes
- Vehicle Speed Control System Electrical Malfunction
    - "Special Communication Device?" – i.e. a CB radio
    - "During the alleged event, was the HVAC operating?"
    - "Was the radio on? If so, was there any static preceding or during the event?"
    - "Test vehicle response to all modes of speed control"
    - "Inspect wiring harnesses and insure there are no pinched, chaffed or disconnected wires"
    - "Inspect that all grounds are connected and check for any evidence of water entry into the connectors"

26 February 10, 1987 – Accident report for Richard C. Kosik, Ford Light Truck Engineer, for injuries sustained in a sudden acceleration event in a Ford garage

- Had just completed an NVH evaluation (noise, vibration, and harshness) on an Aerostar AWD experimental prototype vehicle, pulled vehicle into garage.
- Was attempting to move the car to an outside parking area and "upon shifting the transmission from park to overdrive, the vehicle rapidly accelerated at a very full-throttle condition, squealing tires at its initial movement." Kosik did not recall ever touching the accelerator pedal.
- Initially Kosik removed feet from all pedals, but car continued to accelerated
- Put transmission in park and hit a wall after swerving to avoid parked cars and bystanders, traveled 55 feet.

27 March 3, 1987 – "Proposed EMC Improvement and Connector Change on Speed Control Module"

- This document outlines the history of EMC problems in the speed control module, and proposes a fix for better immunity
- "Test results have grown progressively worse. Today, every car line tested at Romeo shows susceptibility on many frequencies. This is due to the increased use of plastic and wiring complexity on the new vehicles. The testing at Romeo is showing up problem frequencies that were missed in vehicle testing using transmitters."
- A total of 12 capacitors were added to input lines and at the integrated circuit
- The original edge-board connectors were replaced because "this type of connector is known to cause problems on low current circuits such as the speed control servo position feedback circuit."
- Cost of parts per vehicle was $3.50, with additional costs for re-tooling.
- In trial, Ford has repeatedly stated that this design change was only for vehicles brought back due to problems with EMC from various radio transmitters such as a CB radio. Ford tries to present the notion that they knew exactly what frequencies were causing these problems, but by putting

capacitors on all input lines, it appears that they did not know exactly what the cause was and they were trying to protect from all RF frequencies. This should have been done from the beginning on all speed control modules in every model of car and truck produced.

- This document ties into the Fordemc website discussed in #54. It shows that although the EMC document was posted to the web in 2001 its contents were known by Ford in and before 1987. A comparison of this document to contents of the Fordemc is given in #54. In trial Ford has claimed that the contents of this document cannot be used for a case involving a vehicle manufactured prior to 2001 as the information contained may not have been known to Ford at that time.
- This document was never given to NHTSA for its 1989 study of sudden acceleration. The NHTSA study does not contain any mention of the susceptibility of the cruise to EMC as stated in the fix which was known in 1987. The fix contains the protection of the board at every connection point since Ford had no idea as to which path the signal took. In fact, all of the fix, which includes the tinning thru of the holes, vias, and the ground loop, are an overall protection from all signals on all pathways. The NHTSA study had a very naïve statement regarding the ability to identify any disruptive signal which is contrary to Ford's experience which Ford did not share with NHTSA.
- This document also substantiates the findings of the TAC as discussed in #22.
- In this same time period GM engineers were consulting with Hughes Aircraft engineers regarding GM's sudden acceleration problems. The Hughes to GM documents included here express the same opinions regarding the lack of EMI protection that are evident in the Ford cruise control. In fact, the Hughes engineers express the opinion that what they have found equally applies to all auto manufacturers. Particularly significant is the statement regarding the lack of control of the wiring in the harness assemblies. Hughes also comments on the lack of coordinated efforts in design and investigation that was brought out in the Ford TAC documents.

28 June 15, 1987 – Ford Quality Team Meeting minutes (Bates number "1939 0408")

- "G. Klinger – EMC fix for standalone amplifier rejected due to cost." The cost referred to is $2.99 – an amount any consumer would gladly absorb for the added safety it affords.
- Footnote 3 on Bates page number "1935 1382" states "Required by Ford specs, old design does not meet requirements, cost to add $2.99. Program Managers elected not to add."
- Shows negligence due to attempts at cost-effectiveness.

29 October 1987 – Failure Mode and Effects Analysis of the "Next Generation" cruise control system (Bates number "1972 0195")

- This is one of the earliest documents concerning the new cruise control system. This new system utilizes a stepper motor with an electromagnetic clutch to pull the throttle open instead of a vacuum servo.
- Whenever a part is designed in the automotive industry, a Failure Mode and Effects Analysis is performed on the part. This process identifies the ways parts of systems can fail and the effects of the failure on the rest of the system
- One failure mode of the cruise control system is "throttle will not return to idle". Some of the causes of this failure mode include:
  - Influence of contaminants causing the clutch to stick in the engaged position
  - Excessive buildup of dirt, dust, grease etc. or formation of ice particles causing a motor or gear train mechanical jam
  - Shorted motor driver
  - Cable isn't recoiling properly on retractor mechanism
  - Cable is fraying
  - Bend in cable routing is too severe
  - Dirt, grease, or ice has formed between cable and cable sheath
  - Cable housing is pinched
- The severity level assigned to this risk is 10, on a scale of 1 to 10.

30 1988 – Ford speed control circuitry changed from a stand-alone setup where the circuitry is in a separate housing from the rest of the electronics to an integrated setup where the speed control is integrated into the Electronic Engine Control. This achieved an overall savings of $8.00 per car. This change resulted in a huge spike in reports of unwanted acceleration. After 2 and a half years, the cruise control was separated from the EEC again. Interestingly, the integrated setup had cruise control modules using 48 wires, instead of the 12 wires in the stand-alone setup. This presented an exponentially higher risk of EMI. Ford's reasoning for returning to the stand-alone setup was that changes in the vehicle required the use of the pin locations on the EEC that were used by the cruise wires. This was not true as (for example) the 1990 Town Car with the integrated speed control had 12 unused pin locations, while the 1991 Town Car with the stand-alone setup had 14 unused pin locations.

31 March 2, 1988 – Potential Critical Product Problem – document produced by Ford concerning speed control (Page 10134)

- "The speed control is susceptible to high energy radio transmitters… This contamination can cause the amplifier to either drop out the speed control or cause it to go into the accel mode."
- "The FCC has requirements covering acceptable EMC parameters which our amplifiers do not meet."

32 June 30, 1988 – FMVSS-124 Compliance Test ("Sheet 11")

- This particular document, for a model year 1989 Taurus SHO 3.0L is a "Speed Control Non-Interference Sign-off"
- "The following speed control components supplied for vehicle compliance testing is to verify that the speed control components and packaging does not impede return of the accelerator system as described in the attached Executive Engineer's Final Sign-off"

33 April 19, 1988 – EEC Wiring Harness Direction and Design Review Process with Design Checklist (Bates numbers "2063 0929" through "2063 0942")

- Contains protocol for Design and Review of the EEC wiring harness, connectors, and terminals, much like Ford's EMC website.
- Describes in detail capacitive and inductive coupling and its negative effects, shield grounding, radiation and susceptibility reduction due to twisted wires.

34 October 28, 1988 – "System and method for automatically controlling vehicle speed to desired cruise speed using microcomputer" - #5025379

- Patent by: Nissan Motor Company, Limited
- "a condition of enabling the cruise speed control via the actuator is **disabled** when at least one of the determining factors does not satisfy the condition.

35 1989 --- During this time period studies of sudden acceleration were published by NHTSA, Canadian Transportation Department, and the Japanese Transportation Department. NHTSA put out a study based on misinformation supplied by the auto manufacturers and grossly inadequate sampling and testing methods. The Canadian study mimicked the NHTSA study. The Japanese study found no mechanical reason for sudden acceleration commonality, did not blame operator error, and determined that further study was required of the electronic elements with regards to electromagnetic influences and environmental influences. Chapters 6 and 7 of this report are included in the timeline.

36 19?? – Document titled "Accelerator Splash Shield Design Process" by J.A. Conrad

- Document details the design process of a splash shield to be fitted on Ford vehicles

- “The splash shield is designed to protect the accelerator cable and return springs, speed control cable, and the throttle linkage from water, ice and snow that can collect and freeze causing the throttle to stick or bind.”

37 March 12, 1990 – Dealer Contact Report concerning Sudden Acceleration problems with rented Hertz vehicles. (Bates numbers “3426 0160” through “3426 0167”)

- Report describes two technicians driving vehicle and engaging cruise control
- Brake on/off switch, cruise off switch, and coast buttons did not disengage cruise control
- Dump valve was manually activated, and the vehicle took 5 to 6 seconds to return to idle

38 1991 – Aerostar, Explorer, Ranger Truck Shop Manual Volume 1 of 2: Engine/Chassis (Section 10-03)

- The following CAUTION warning is printed twice on the same page in this manual. Once for a simulated speed control test, and once for the road test of the speed control.
- “CAUTION: If at any time during the following steps the system should appear to go out of control and overspeed, be prepared to turn the system off at once with the off switch or the ignition switch”
- This shows that Ford knew that Sudden Acceleration was possible in these models. They warned their employees, but not their customers.

39 January 31, 1991 FMEA for the Next Generation Cruise Control System’s Electronics (available on disc in .pdf format)

- Several interesting failure effects, including:
- Loss of RF noise immunity
- Increased Radiated Emissions
- Increased Radiated Susceptibility
- Loss of transient Immunity
- Increased Conducted Emissions
- Reduced transient suppression

40 May 7, 1991 – Updegrove questionnaire and accident report filed by Ford employee Jack Caldwell, after experiencing sudden acceleration in a nearly new “World Headquarters garage” Mercury Grand Marquis (Bates numbers “3422 0473” through “3422 0477”)

- Car was parked with the engine off, Caldwell entered the vehicle, started the engine with a normal idle, engaged the transmission in drive, and the car spun its wheels and took of without touching the accelerator.
- Caldwell stopped the car by depressing the brake pedal with all of his strength and placing the transmission in Park
- The vehicle left visible skidmarks on the painted concrete surface, and traveled 12 to 15 feet.

41 1994 – A boot for the speed control cable is designed. This boot may or may not have ever been installed on any vehicles.

42 April 3, 1995 – “Throttle Valve Control Device” - #5490487

- Patent by: Nippondenso Company Limited
- “The throttle valve is prevented from opening excessively when the electric control system fails and the throttle valve may be controlled in both directions by the motor”

43 March 4, 1996 – “Short Circuit Protection System” - #5694282

- Patent by: Ford Motor Company

- Semi-conductor device which detects and prevents short circuits

44 May 10, 1996 – "Electromagnetic Interference protection and CTE control of three dimensional circuitized substrates" - #5929375

- Patent by: Ford Motor Company
- The fact that EMI is being protected against once again proves that Ford had knowledge of its existence and possible negative effects.

45 September 24, 1996 – Deposition of Victor J. Declercq, a Ford Expert Engineering Witness, Manigault vs. Ford, Page 122

- In this deposition, Declercq is asked, "Do I infer correctly that one of the functions of this dump valve is to override the cruise control in the event of an unwanted acceleration?" To which Declercq replies, "That is one of the functions of the dump valve."
- "May I not infer then that this is designed in light of the fact that unwanted accelerations may occur?" to which Declercq replies, "Yes."

46 April 4, 1997 – Ford Service Recall Bulletin #97S65 – Speed control cable modification

- This Recall affected 1991-1994 Lincoln Town Cars and 1991-1995 Taurus/Sables.
- Strangely, the Lincoln Continental and Ford Crown Victoria, which share a platform with the Town Car are not included in this recall
- "When operating one of these vehicles with the speed control engaged in temperatures well below freezing over an extended period of highway travel the throttle may not return to idle when the speed control is disengaged. If this occurs the engine speed would remain the same even though the speed control is disengaged creating the risk of a vehicle crash.
- "To correct this condition, dealers are to blow out any accumulated water in the speed control cable, install a boot on the existing cable, and retain it with a tie strap"
- Later that year, RHD Ford Explorers and Mercury Mountaineers were recalled for the same fix (NHTSA Campaign #99V062000)

47 October 10, 1997 and June 9, 2004 – FMEAs for the Next Generation Cruise Control System (no significant revisions in the 2004 document, both are available on disc in .pdf format)

- Causes for the Failure Modes of the Speed Control system which could cause symptoms of sudden acceleration and failure to decelerate events. Because these failure modes are listed in both the 1997 and 2004 FMEAs, Ford not only knew about it back in 1997, but hadn't changed the system to eliminate these failures as of 2004. Some of the listed failure modes are:
  - Accelerates at an abnormal rate
  - Accelerates beyond the release of the switch
  - Sticky mechanisms
  - Does not maintain set speed on an incline, decline, level surface, or in adverse environmental conditions
  - Speed control does not disengage per any driver command
  - Speed control does not disengage with the off switch
  - Speed control does not disengage with the BOO (brake on-off) switch
  - Does not disengage with brake pedal input (deact. switch)
  - Acceleration/Deceleration at an undesired rate
- Potential Causes of these failure modes are basically repeated verbatim for each failure mode. These causes include:
  - **EMC susceptibility**
    - This cause is listed as a cause for many different failure modes, including "vehicle does not maintain set speed", "Sticky mechanisms", and "Vehicle accelerates at an abnormal rate"

- ***<u>Recommended Actions: "Because of the low occurrence and detection ratings, the team has determined that no further actions are required" – this comment shows Ford's general attitude towards EMI and the effectiveness of their EMC testing.</u>***
  <u>This same attitude towards a problem with low occurrence rate and detection rating is reflected in the NHTSA ODI Resume PE93-011 regarding the stand alone cruise control in 1986 through 1988 Mustangs.</u>
- This cause is repeated many times throughout this FMEA

- "Sticky" mechanisms: throttle body, speed control cable, accelerator cable
- Actuator issues
- Binding of mechanical components
- Bearing seizes or other bearing issues including misposition or lack of adequate retainer
- Pulley not seated on shaft
- Incorrect clutch retainer lubricant
- Lack of proper seals – not chemically inert
- Neighboring sub-systems (EMC?)
- Environment
- Water ingress into cable at freezing temperatures
- Water ingress into servo - corrosion
- Slug positioned backwards
- Cable manufacturing defects:
  - Frayed core wire
  - Kinked core wire
  - Excessive flash in cavities
  - Extra slug in lost motion device
  - Inadequate cable lubrication
  - Cable pinched in conduit
  - "Insufficient overlap between cable conduit and end connector strand cover will permit the two ends to butt during speed control operation resulting in flaring of the ends which binds the cable"
- BOO [switch] message intermittent
- Inappropriate software logic

➢ One particular failure mode that stands out is:
  - "[Speed Control] does not disengage when speed out of operational range" (below 26mph)
  - The recommended action for this failure mode is, "Customer annoyance – observed only by discriminating customer"
  - Combine this failure mode with any of the "Does not maintain set speed" or "Deceleration at an undesired rate" failure modes and the driver would be put in serious danger. Danger of a collision or loss of control is certainly more than an annoyance.

48 January 15, 1998 – Ford internal e-mail concerning the EGR valve and sticking throttles

➢ 1st quarter of 1997 a new EGR tube was installed on 4.0L Explorers
  - The new tube is vertical, while the old tube had a 90 degree bend inside of the intake which pointed at the throttle body.
  - New tube reduced throttle body temperatures by 100 degrees.
  - The old design must have had an outrageously high operating temperature, since a small design change brought the temperature down by 100 degrees.

➢ Even though the change brought the throttle body temperature down by 100 degrees, it did not affect reports of sticking throttle.
  - "My concern is that we have not seen an improvement due to the change that we made to the EGR. The 4.0L SOHC is worse than last year at this time for the sticky throttle issue, and since that time we have implemented the partial t-slot (2/10/97) and the EGR change."

49 March 10, 1998 – "Hypothesized Sludge Deposit and Throttle Sticking Mechanism"

- ➢ This document outlines the process by which “sludge” builds up and binds the throttle body.
  - The reactants “cook”
  - The reactants reach a colder surface and condense on the surface
  - The temperature cycles, changing the viscosity of the sludge from hard to sticky
  - The throttle sticks

50 July 1998 – Ford begins including a “splash protection evaluation procedure” into their corporate engineering test procedure to test the effectiveness of their current splash protection. This test shows how well the components in the engine compartment are protected against water, mud, and salt. (as per documents in Huber vs. Ford)

51 September 21, 1998 – NHTSA recall campaign #98V204000

- ➢ “A dash insulator retainer clip was not fully assembled to the accelerator cable dash fitting. The clip can disengage from the accelerator cable and fall into the accelerator pedal arm pivot area. If this condition occurs, the engine may not fully return to idle. Also, the insulator may not stay in the intended location and could interfere with the accelerator cable.”

52 November 12, 1998 – Ford e-mail correspondences from Casey Mulder (Explorer, U152, and Econoline Speed Control Engineer)

- ➢ First e-mail discusses sudden acceleration problems with RHD Explorers, but then Mr. Mulder discusses wide open throttle braking issues:
  - Admits that braking at WOT is extremely difficult after one pump of the brakes, and the customer would have to press extremely hard on the brake to activate the brake pressure switch.
  - Admits that if pin 4 in the EEC is grounded, the brake on/off switch will not respond, and “incidents just as described by customers could occur.”
  - Bates numbers “3717 7378” through “3717 7379”
- ➢ Second email relays a Ford Quality center technician’s sudden acceleration experience in a RHD Explorer
  - Car reached 110mph before driver braked
  - Bates number “3717 7387”
- ➢ Last email discusses a Ford vice president hitting a pole in his Navigator due to a sudden acceleration event
  - Looked at an Expedition with Jim Cikalo that would accelerate beyond set speed by pressing resume, and would not respond to brakes or off switch.
  - Bates number “3717 7366”

53 1999 – Ford Windstars from this model year are equipped with small “nipple” wipers on the accelerator and cruise control cables where they enter the conduit near the throttle body. This body style of Windstar was introduced in 1995, but the earlier vehicles had unprotected cables.

54 1999 – GM Reference Manual, Tenth Edition, Scanner Snap-on Diagnostics. Indicates that for a low voltage condition the PCM will intentionally run the idle speed of the engine up. In cases of GM products that we have investigated this run up was as high as 2700 rpm.

55 April 4, 2001 (earliest date in the Internet Archive Wayback Machine) – http://www.fordemc.com launched.

- ➢ This website provides EMC specifications and test plans for all Ford part suppliers to conform to.
- ➢ Existence of this website shows that Ford is concerned with Electromagnetic Compatibility, but apparently only as long as it fits within the budget.

- Also included under this section are copies of a few of the thousands of documents that have been published on EMI and EMC. These are included to give some examples of what EMI causes; at least one trade journal article that Ford had in 1986, Machine Design March 6, 1986, that covers the same methods covered in Fordemc document; an SAE published article by Laird Technologies citing the same EMI concerns and fixes; and, an Automotive Electronics Handbook section 14.1.3 on cruise control Failsafe; and, a paper from the EU GEMCAR project discussing the need for evaluation of EMI under installed performance requirements of component interconnection.

- The following is a comparison of the 1987 fix documents, #27, with this website document.

Comparison: Ford Cruise Control History with EMC Design Guide for PCBs

This comparison is based upon two Ford documents which uniquely define Ford's knowledge and actions in regard to EMC and the cruise control. The first is the Proposed EMC Improvement and Connector Change On Speed Control Module, and the second is the EMC Design Guide for Printed Circuit Boards as found on the Ford website Fordemc.com.

I. 1976 - EMC was not noted as being a problem when present speed control system was designed. Therefore no special consideration was given to designing in EMC immunity. Notes that Ford considered and was aware of EMC in 1976, this is in keeping with the EMC Guide stating that EMC concepts are not new and are well established (8/78). Further, the 1976 models were not incorporating the number of electronic and electrical devices which would evolve over the years.

II. 1979 - Car Development had issued several Product Problem Reports against speed control for performance problems during EMC testing. The 1979 models are using more electrical and electronic devices than in 1976 and internal or intra-system EMC is required. This is as stated in the EMC Guide 10/78. The fact that the number of radiating devices will increase EMI is stated in 11/78.

III. 1980 - A copper ground plane is added to the component side of the PW board. This provided satisfactory protection until about 1983. Over the three year period the number and complexity of the systems increased as did the amount of wiring. This is all covered by the Guide in 11/78, 13/78, 14/78, 26/78, 28/78.

IV. 1983 – "Test results have grown progressively worse. Today, every car line tested at Romeo shows susceptibility on many frequencies. This is due to the increased use of plastic and wiring complexity on the new vehicles. The testing is showing up problem frequencies that were missed in the vehicle testing using transmitters." This statement is one which deals with numerous frequencies that are affecting the cruise not just the two which are stated as being from high powered transmitters. It also states that the plastic and wiring are at fault. This is because the plastic is not a shield and the wiring is both a receptor and a radiation source. These are basic EMC considerations which are discussed at length in the Guide from 14/78 on.

V. The conversion from the stand alone to the integrated unit had only one major difference and that was the number of wires which could interact with the cruise control electronics. In the stand alone there were only eleven wires which were directly connected to the cruise electronics making 2^{11} (2048) possible combinations of signals which can result from these wires alone. The Guide at 26/78 refers to these signals in the common mode current section and agrees that hundreds of signals contribute to the overall effect. When the cruise was integrated the number of wires connected to the EEC became the number which could directly effect the cruise. In this case there were nearly sixty wires, therefore, 2^{60} (1.15 billion billion)possible signals contributing to the overall effect. The models with integrated units had a dramatic increase in the number of incidents over the stand alone. The return to the stand alone type units resulted in a drop in the number of reported incidents.

VI. The 1987 document details the fix which is comprised of the basic fixes which are discussed in the Guide. The vacuum based stand alone fix did not incorporate the change in the connector from an edge type to a pin type.

VII. The change to the stand alone next generation incorporated all of the fix components, minimized the plastic on the case and used steel for shielding, but did nothing to protect the wiring. On page two of the 1987 document it cites under Legal/liability concerns " EMI insensitivity required" in conjunction with going to the next gen system.

VIII. The slip ring discussion on page three of the 1987 document indicates that the slip ring was and is a source of spikes and that a solution for immunity is being sought.

In general, the Guide on 51/78 regarding early consideration of EMC design is the negligence in a nutshell.

56 February 19, 2002 – Charles Adams, a Ford expert engineering witness, admits in a deposition that the entry and build-up of foreign material within the cable assembly is "certainly possible" and could result in possible binding of the cable, not allowing the throttle to return to idle. (as per documents from Huber vs. Ford Motor Company – Adams deposition – 57:8 to 58:9)

57 November 5, 2002 – Memo to Attorney Edgar Heiskell from Engineer Dror Kopernik, P.E. concerning the evaluation of testing done by Ford Expert Engineering Witness Lee Carr

- Concerning Carr's foot position on the brake pedal during the test, "By resting the left edge of the foot on the pedal and rotating it towards the transducer it is possible to obtain force readings lower than the actual force being applied."

58 November 19, 2002 - Patent 6647959, Inventors Noguchi, Takuro; assigned to Mitsubishi et al. Fail-safe device for electronic throttle control system. This is a patent related to making the drive-by-wire system safe. This type of system removes all of the mechanical connections to the throttle valve and replaces them with a small electric motor on the valve arm. The accelerator pedal operates a variable resistor arrangement that sends voltage values to the electronic engine controller that are calibrated to generate output signals from the controller to the motor to move the throttle arm. This system represents a return to the IVSC concept. In the vehicles that employ this drive-by-wire system it is not uncommon to have a hundred or more wires connected to the controller, none of which are adequately protected. Drive-by-wire sudden acceleration reports are becoming common with Toyota leading in number of reports at present.

59 August 2003 – Ford Safety Recall 03S03

- The end of the strand cover component of the cruise control cable assembly can flare or split, causing a binding condition. If the plastic splits and a piece of plastic breaks free, this piece itself may bind the cable.
- This condition was known as far back as 1997. (see document #46 under "cable manufacturing defects")

60 March 7, 2005 – Deposition of Ford expert engineering witness Victor Declerq

- From attached testing documents and statements made in deposition, compound signals are still not tested for – increasing the power of the EMI does not equate to the actual, real-world conditions experienced in a vehicle. Additionally, this does not prove that the components are immune because a waveform with larger amplitude is NOT equivalent to a compound waveform. The components are only subjected to discrete frequencies with varying strengths. In addition, the components are tested *outside* of the car which makes testing them as if they were actually installed in the vehicle impossible.
- When asked if he agreed with the part of Sero's EMI theory concerning millions upon millions of combinations of amplitudes, frequencies, and interactions of different signals, Declerq responded

"No question about that". However, he conveniently distorts and misstates Sero's theory multiple times throughout this deposition.

- When asked if Ford's testing was sufficient to test for these millions upon millions of combinations, Declerq responds, "That's correct. What I would compare it to, Mr. Sero is addressing and he is suggesting that this field of grass – the level of height of this field of grass is sufficient to cause some kind of abnormality. And actually at Ford, the testing was to the height of the real world as compared to a forest of oak trees."
  - This comment almost makes Ford's testing sound obsolete, since they do not test the exact conditions found in the real world. Instead of grass and oak trees, Mr. Declerq may just as well have said apples and oranges.
- States that, "In the seventies that vast majority of vehicles were manual transmissions" and that the automatic transmission was just being introduced. This is a bold-faced lie, completely untrue. In fact, the first automatic transmission, the Hydra-Matic, was introduced in 1938 by Oldsmobile, and the majority of cars sold in North America since the 1950's have been equipped with automatic transmissions.