

EA02-025

FORD 10/27/03

APPENDIX N

BOOK 17 OF 61

PART 2 OF 4

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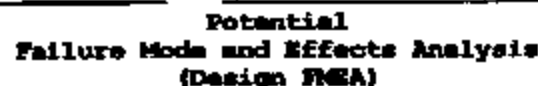
3713 1874

Design Feasibility: Within Speed Control System Engineering
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3713 1975



Design Responsibility: Vietnam Space Control System Registry
NCS 00001

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3713 1977

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Device Responsibility: Vision and Sensor System Engineering
not done

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Reviewed by:

WISN, Dallas, January 3: 1967, vol. 12 (Nov. 3: 1991, pp. 94

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Tommy Todd, Ed Johnson, Larry Leary, Sam Johnson, Martha Graham, and Friedrich.

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3713 1878

Potential Failure Mode and Effects Analysis (Design FMEA)

Page Number: _____
 Page 27 of 28
 Prepared by: _____
 FMEA Date (YYYY-MM-DD) (Rev.): 1997-02-12 (Rev.): 1997-04-04

Customer: Automatic Vehicle Speed Control Subsystem (AVSC)

Model Year/Model(s): 1998 / FORD/Explorer

Core Team: Pat Hahn, Larry Harvey, Jim Vukobrat, Darrin Swanson, Mark Friedman

Design Responsibility: Vehicle Speed Control System Engineering

Rev Date: _____

Design Number: _____

Item	Potential Failure Mode	Potential Effect(s) of Failure	S	O	D	Potential Cause(s) / Mechanism(s) of Failure	C	S	O	D	Current Design Controls	Recommended Action(s)	Responsibility & Target Completion Date	Action Status	Action			
															Y	M	D	Y
						Indefinite engine stall Stall	1	1	1	1	1	1. No further action required.						
						Intermittent engine stall	1	1	1	1	1	1. No further action required.						
						Intermittent engine stall	1	1	1	1	1	1. No further action required.						
						Intermittent engine stall	1	1	1	1	1	1. No further action required.						
						Intermittent engine stall	1	1	1	1	1	1. No further action required.						
						Intermittent engine stall	1	1	1	1	1	1. No further action required.						
						Intermittent engine stall	1	1	1	1	1	1. No further action required.						
						Intermittent engine stall	1	1	1	1	1	1. No further action required.						
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						Intermittent engine stall	1	1	1	1	1	1. No further action required.						
						Intermittent engine stall	1	1	1	1	1	1. No further action required.						
						Intermittent engine stall	1	1	1	1	1	1. No further action required.						
						Intermittent engine stall	1	1	1	1	1	1. No further action required.						
						Intermittent engine stall	1	1	1	1	1	1. No further action required.						
						Intermittent engine stall	1	1	1	1								

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Keywords:

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Revised to: November 1999

FILMNO:

3713 1981

Potential Failure Mode and Effects Analysis (Design FMEA)

System: **5713**
Component: **Automatic Vehicle Speed Control Subsystem (AVSC)**
Model Name/Version: **1997 / 10000000000**
Core Team: **Bob Smith, Larry Lacey, Sam Fabela, Donna Grady, Mark Schindler**

Design Responsibility: **Vehicle Speed Control System Engineering**
Rev Date:

Rev Number:
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Prepared by:
Date: **1997.02.11 (Rev. 1: 1997.02.10)**

Item	Functional Failure Mode	Functional Impacts of Failure	C	Potential Cause(s) / Effect(s)	Current Design Controls	S	Recommended Action(s)	Responsibility & Target Completion Date	Action Taken	Reviewed By	Reviewed Date
1	Below 0% speed acceleration available of the set speed	Does not permit manual acceleration override	Loss of primary subsystem Function-1	Provide independent lane control	1. Initial Over-ride 11 Functional Description 20 Functional Reliability 40 Design Competibility Review	1	1. Establish the specification for this function and test at the PMA.	Sam Fabela 12-1-97			
				"Sticky" mechanism -throttle bodies -speed control solenoid -accelerator solenoid -throttle	1. Initial Over-ride 11 Functional Description 20 Functional Reliability 40 Design Competibility Review	1	1. No further actions required.				
		Does not return to the set speed upon release of the override	Loss of primary subsystem Function-1	Provide independent lane control	1. Initial Over-ride 11 Functional Description 20 Functional Reliability 40 Design Competibility Review	1	1. No further actions required.				
				"Sticky" mechanism -throttle bodies -speed control solenoid -accelerator solenoid -throttle	1. Initial Over-ride 11 Functional Description 20 Functional Reliability 40 Design Competibility Review	1	1. No further actions required.				
				Locks, fitting issues with hardware -improper installation	1. Initial Over-ride 11 Functional Description 20 Functional Reliability 40 Design Competibility Review	1	1. No further actions required.				
2	Below 0% over-ride of the subsystem per user guidelines	Does not allow the over-ride of the subsystem.	Loss of primary subsystem Function-1	Provide independent lane control	1. Initial Over-ride 11 Functional Description 20 Functional Reliability 40 Design Competibility Review	1	1. No further actions required.				
				Locks, fitting issues with hardware -improper installation	1. Initial Over-ride 11 Functional Description 20 Functional Reliability 40 Design Competibility Review	1	1. No further actions required.				
				High packaging	1. Initial Over-ride 11 Functional Description 20 Functional Reliability 40 Design Competibility Review	1	1. No further actions required.				
				Insufficient clearance	1. Initial Over-ride 11 Functional Description 20 Functional Reliability 40 Design Competibility Review	1	1. No further actions required.				
				Insufficient design review	1. Initial Over-ride 11 Functional Description 20 Functional Reliability 40 Design Competibility Review	1	1. No further actions required.				

3713 1992



1999, 2000, 2002-03, 2004-05, 2006-07, 2008-09, 2010-11, 2012-13, 2014-15, 2016-17, 2018-19, 2020-21

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World Travel by: Andrew W. Brown

3718 1984



Electrical Engineering: Systems, Control, System Engineering

Approved By:

Approved By:

2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578, 2579, 2580, 2581, 2582, 2583, 2584, 2585, 2586, 2587, 2588, 2589, 2590, 2591, 2592, 2593, 2594, 2595, 2596, 2597, 2598, 2599, 2600, 2601, 2602, 2603, 2604, 2605, 2606, 2607, 2608, 2609, 2610, 2611, 2612, 2613, 2614, 2615, 2616, 2617, 2618, 2619, 2620, 2621, 2622, 2623, 2624, 2625, 2626, 2627, 2628, 2629, 2630, 2631, 2632, 2633, 2634, 2635, 2636, 2637, 2638, 2639, 2640, 2641, 2642, 2643, 2644, 2645, 2646, 2647, 2648, 2649, 2650, 2651, 2652, 2653, 2654, 2655, 2656, 2657, 2658, 2659, 2660, 2661, 2662, 2663, 2664, 2665, 2666, 2667, 2668, 2669, 2670, 2671, 2672, 2673, 2674, 2675, 2676, 2677, 2678, 2679, 2680, 2681, 26

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2nd Vice: Don Babin, Larry Leary, Tom Finkbe, Imette Goodin, Mark Velichich

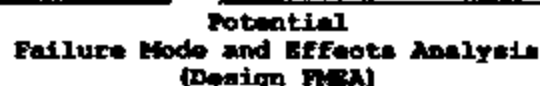
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6-100000-1 (continued) 6-1 1992

8713 1985



Region Responsibility: Western North America Region Headquarters

NAME (Last, First):

Page 44 of 45

Keywords: child sexual abuse; disclosure; self-blame; social support

1997-2007

Model year/Make/Model: 1991 / Chevrolet / Cavalier

Best Price

Curry Tamm, Robt. Hefner, Larry Schreyer, Sam Hefner, Ronald Brinkman, Mark Friedland

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Keywords: *workplace spirituality, organizational commitment, organizational citizenship behavior, turnover intention*

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3713 1508

Potential Failure Mode and Effects Analysis (Design PFMEA)									
System: Automotive Vehicle Speed Control System 1987		Design Responsibility: Vehicle Speed Control System Engineering				Date: 1987-08-10			
Component: Automatic Vehicle Speed Control System 1987		By: John Doe				Page: 40 of 40			
Vehicle: 1987 / 1988 / 1989		Part Name: Automatic Vehicle Speed Control System 1987				Project: 1987-08-10			
Customer: General Motors		Part Name: Automatic Vehicle Speed Control System 1987				Revision: 1.0			
Item	Function	Potential Failure Mode	Potential Effect of Failure	Potential Cause of Failure	Current Design Controls	Severity	Occurrence	Detectability	Action
1	Control vehicle speed	Excessive speed	Excessive speed	Excessive speed	Excessive speed	1	1	1	1
2	Control vehicle speed	Excessive speed	Excessive speed	Excessive speed	Excessive speed	1	1	1	1
3	Control vehicle speed	Excessive speed	Excessive speed	Excessive speed	Excessive speed	1	1	1	1
4	Control vehicle speed	Excessive speed	Excessive speed	Excessive speed	Excessive speed	1	1	1	1
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9	Control vehicle speed	Excessive speed	Excessive speed	Excessive speed	Excessive speed	1	1	1	1
10	Control vehicle speed	Excessive speed	Excessive speed	Excessive speed	Excessive speed	1	1	1	1
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18	Control vehicle speed	Excessive speed	Excessive speed	Excessive speed	Excessive speed	1	1	1	1
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41	Control vehicle speed	Excessive speed	Excessive speed	Excessive speed	Excessive speed	1	1	1	1
42	Control vehicle speed	Excessive speed	Excessive speed	Excessive speed	Excessive speed	1	1	1	1
43	Control vehicle speed	Excessive speed	Excessive speed	Excessive speed	Excessive speed				

NAME (Print)

DATE Recd. No. 1: 1977.05.12 May, 1: 1977.05.20

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inglês: **em: Multilane Flow**

3713 1807



Potential Failure Mode and Effects Analysis (Design FMEA)

System: **Automatic Vehicle Speed Control (AVC)**
Component: **Automatic Vehicle Speed Control (AVC)**
Model Year/Vehicle(s): **1992 / Suburban/Explorer**

Design Responsibility: **Vehicle Speed Control System Engineering**
Key Note:

Rev. Number:
Page 10 of 10

Prepared By:

Rev. Date (Orig.): 1997.02.10 (Rev.): 1997.06.20

Case Name: **AVC Malfunction, Early Warning, Run Vehicle, Brakes Work, No Windshield**

Item	Potential Failure Mode	Potential Effects of Failure	Severity 1-10	Internal Controls/ Mechanical Failure	Current Design Controls	Severity 1-10	Recommended Action(s)	Responsibility & Target Completion Date	Actions Taken	Severity 1-10	Internal Controls/ Mechanical Failure	Current Design Controls	Severity 1-10
Item 10	AVC Malfunction	AVC Malfunction - Operates only by determining vehicle speed.	2	Backuping constraints overcome protection High cost Loss of system guidance	20 20 20 20	20 20 20 20	20 20 20 20	20 20 20 20	20 20 20 20	20 20 20 20	20 20 20 20	20 20 20 20	20 20 20 20

3713 1998

FD-302a (Rev. 4-15-64) (Instructions on reverse side)

in North [Tynes], map distance 100-120

Author's Address: Department of Psychology, University of Illinois at Chicago, Chicago, IL 60607, USA.

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Design Magnification: Minimum Speed Control System Type

Immunized 400/1

1997-1998, 1999-2000, 2001-2002, 2003-2004, 2005-2006, 2007-2008, 2009-2010, 2011-2012, 2013-2014, 2015-2016, 2017-2018, 2019-2020, 2021-2022, 2023-2024, 2025-2026, 2027-2028, 2029-2030, 2031-2032, 2033-2034, 2035-2036, 2037-2038, 2039-2040, 2041-2042, 2043-2044, 2045-2046, 2047-2048, 2049-2050, 2051-2052, 2053-2054, 2055-2056, 2057-2058, 2059-2060, 2061-2062, 2063-2064, 2065-2066, 2067-2068, 2069-2070, 2071-2072, 2073-2074, 2075-2076, 2077-2078, 2079-2080, 2081-2082, 2083-2084, 2085-2086, 2087-2088, 2089-2090, 2091-2092, 2093-2094, 2095-2096, 2097-2098, 2099-2100, 2101-2102, 2103-2104, 2105-2106, 2107-2108, 2109-2110, 2111-2112, 2113-2114, 2115-2116, 2117-2118, 2119-2120, 2121-2122, 2123-2124, 2125-2126, 2127-2128, 2129-2130, 2131-2132, 2133-2134, 2135-2136, 2137-2138, 2139-2140, 2141-2142, 2143-2144, 2145-2146, 2147-2148, 2149-2150, 2151-2152, 2153-2154, 2155-2156, 2157-2158, 2159-2160, 2161-2162, 2163-2164, 2165-2166, 2167-2168, 2169-2170, 2171-2172, 2173-2174, 2175-2176, 2177-2178, 2179-2180, 2181-2182, 2183-2184, 2185-2186, 2187-2188, 2189-2190, 2191-2192, 2193-2194, 2195-2196, 2197-2198, 2199-2200, 2201-2202, 2203-2204, 2205-2206, 2207-2208, 2209-2210, 2211-2212, 2213-2214, 2215-2216, 2217-2218, 2219-2220, 2221-2222, 2223-2224, 2225-2226, 2227-2228, 2229-2230, 2231-2232, 2233-2234, 2235-2236, 2237-2238, 2239-2240, 2241-2242, 2243-2244, 2245-2246, 2247-2248, 2249-2250, 2251-2252, 2253-2254, 2255-2256, 2257-2258, 2259-2260, 2261-2262, 2263-2264, 2265-2266, 2267-2268, 2269-2270, 2271-2272, 2273-2274, 2275-2276, 2277-2278, 2279-2280, 2281-2282, 2283-2284, 2285-2286, 2287-2288, 2289-2290, 2291-2292, 2293-2294, 2295-2296, 2297-2298, 2299-2300, 2301-2302, 2303-2304, 2305-2306, 2307-2308, 2309-2310, 2311-2312, 2313-2314, 2315-2316, 2317-2318, 2319-2320, 2321-2322, 2323-2324, 2325-2326, 2327-2328, 2329-2330, 2331-2332, 2333-2334, 2335-2336, 2337-2338, 2339-2340, 2341-2342, 2343-2344, 2345-2346, 2347-2348, 2349-2350, 2351-2352, 2353-2354, 2355-2356, 2357-2358, 2359-2360, 2361-2362, 2363-2364, 2365-2366, 2367-2368, 2369-2370, 2371-2372, 2373-2374, 2375-2376, 2377-2378, 2379-2380, 2381-2382, 2383-2384, 2385-2386, 2387-2388, 2389-2390, 2391-2392, 2393-2394, 2395-2396, 2397-2398, 2399-2400, 2401-2402, 2403-2404, 2405-2406, 2407-2408, 2409-2410, 2411-2412, 2413-2414, 2415-2416, 2417-2418, 2419-2420, 2421-2422, 2423-2424, 2425-2426, 2427-2428, 2429-2430, 2431-2432, 2433-2434, 2435-2436, 2437-2438, 2439-2440, 2441-2442, 2443-2444, 2445-2446, 2447-2448, 2449-2450, 2451-2452, 2453-2454, 2455-2456, 2457-2458, 2459-2460, 2461-2462, 2463-2464, 2465-2466, 2467-2468, 2469-2470, 2471-2472, 2473-2474, 2475-2476, 2477-2478, 2479-2480, 2481-2482, 2483-2484, 2485-2486, 2487-2488, 2489-2490, 2491-2492, 2493-2494, 2495-2496, 2497-2498, 2499-2500, 2501-2502, 2503-2504, 2505-2506, 2507-2508, 2509-2510, 2511-2512, 2513-2514, 2515-2516, 2517-2518, 2519-2520, 2521-2522, 2523-2524, 2525-2526, 2527-2528, 2529-2530, 2531-2532, 2533-2534, 2535-2536, 2537-2538, 2539-2540, 2541-2542, 2543-2544, 2545-2546, 2547-2548, 2549-2550, 2551-2552, 2553-2554, 2555-2556, 2557-2558, 2559-2560, 2561-2562, 2563-2564, 2565-2566, 2567-2568, 2569-2570, 2571-2572, 2573-2574, 2575-2576, 2577-2578, 2579-2580, 2581-2582, 2583-2584, 2585-2586, 2587-2588, 2589-2590, 2591-2592, 2593-2594, 2595-2596, 2597-2598, 2599-2600, 2601-2602, 2603-2604, 2605-2606, 2607-2608, 2609-2610, 2611-2612, 2613-2614, 2615-2616, 2617-2618, 2619-2620, 2621-2622, 2623-2624, 2625-2626, 2627-2628, 2629-2630, 2631-2632, 2633-2634, 2635-2636, 2637-2638, 2639-2640, 2641-2642, 2643-2644, 2645-2646, 2647-2648, 2649-2650, 2651-2652, 2653-2654, 2655-2656, 2657-2658, 2659-2660, 2661-2662, 2663-2664, 2665-2666, 2667-2668, 2669-2670, 2671-2672, 2673-2674, 2675-2676, 2677-2678, 2679-2680, 2681-2682, 2683-2684, 2685-2686, 2687-2688, 2689-2690, 2691-2692, 2693-2694, 2695-2696, 2697-2698, 2699-2700, 2701-2702, 2703-2704, 2705-2706, 2707-2708, 2709-2710, 2711-2712, 2713-2714, 2715-2716, 2717-2718, 2719-2720, 2721-2722, 2723-2724, 2725-2726, 2727-2728, 2729-2730, 2731-2732, 2733-2734, 2735-2736, 2737-2738, 2739-2740, 27

Curry, West, Sam Roberts, Sam Roberts, Tim West, The Ticks (Tele-Ton), John West (Wednes), Day Roberts (M-Land)

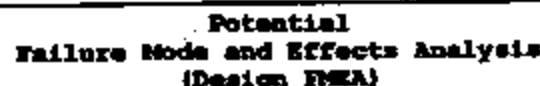
[illegible]



Carol Tamm, Sam Mathias, Sam Rindquist, Wm. Bach, Wm. Tilden [Delellor], John Wright [Gardner], my father-in-law

Produkt von: 3,4mm.44 und 09:00:23
Erstellt in: Microsoft Word 2003

3713 1987



**Foreign Corresponding: Vietnam Speed Control System Begins
New Work:**

Prepared by:

gross value dec'd: 1979, 46.26 (mar.); 1980, 46.66

FROM: SAC, NEW YORK (100-368611) TO: DIRECTOR, FBI (100-368611) (P)
SUBJECT: [REDACTED] (C) (U)

Produced on: 2009-04-09 09:05:24
Generated by: GnuPGMail, 1.0.1

submitted to: AMC@jku.edu that

3713 1882



FROM: Prother:
 Page: 2 of 2
 Prepared by:
 USAM: from orig.s: 1007.10.20 (max.s: 1000.00.02)

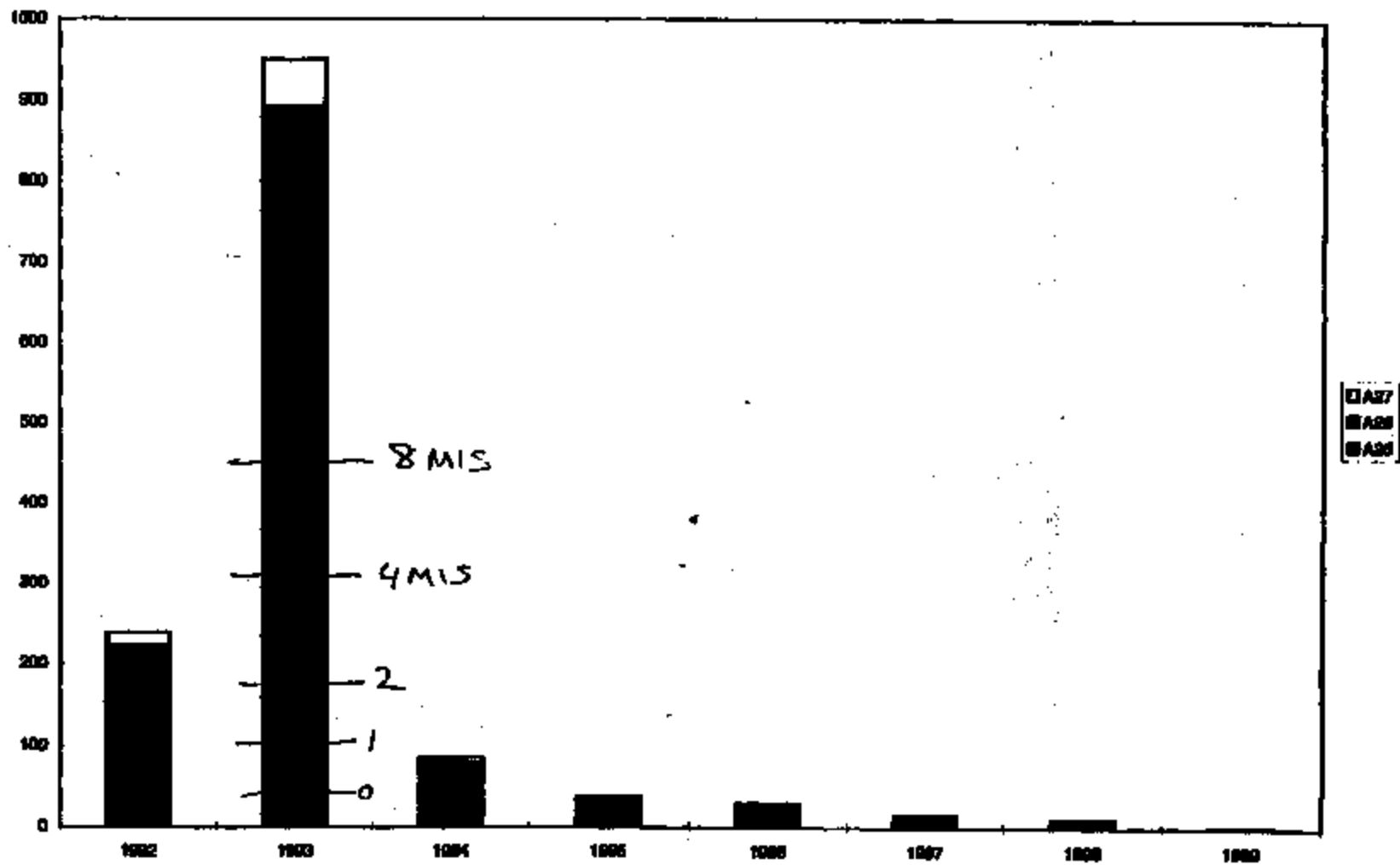
File name:
C:\Users\user\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\...

3713 1893



3713 1994

Economize Speed Control Claims



3713 1885

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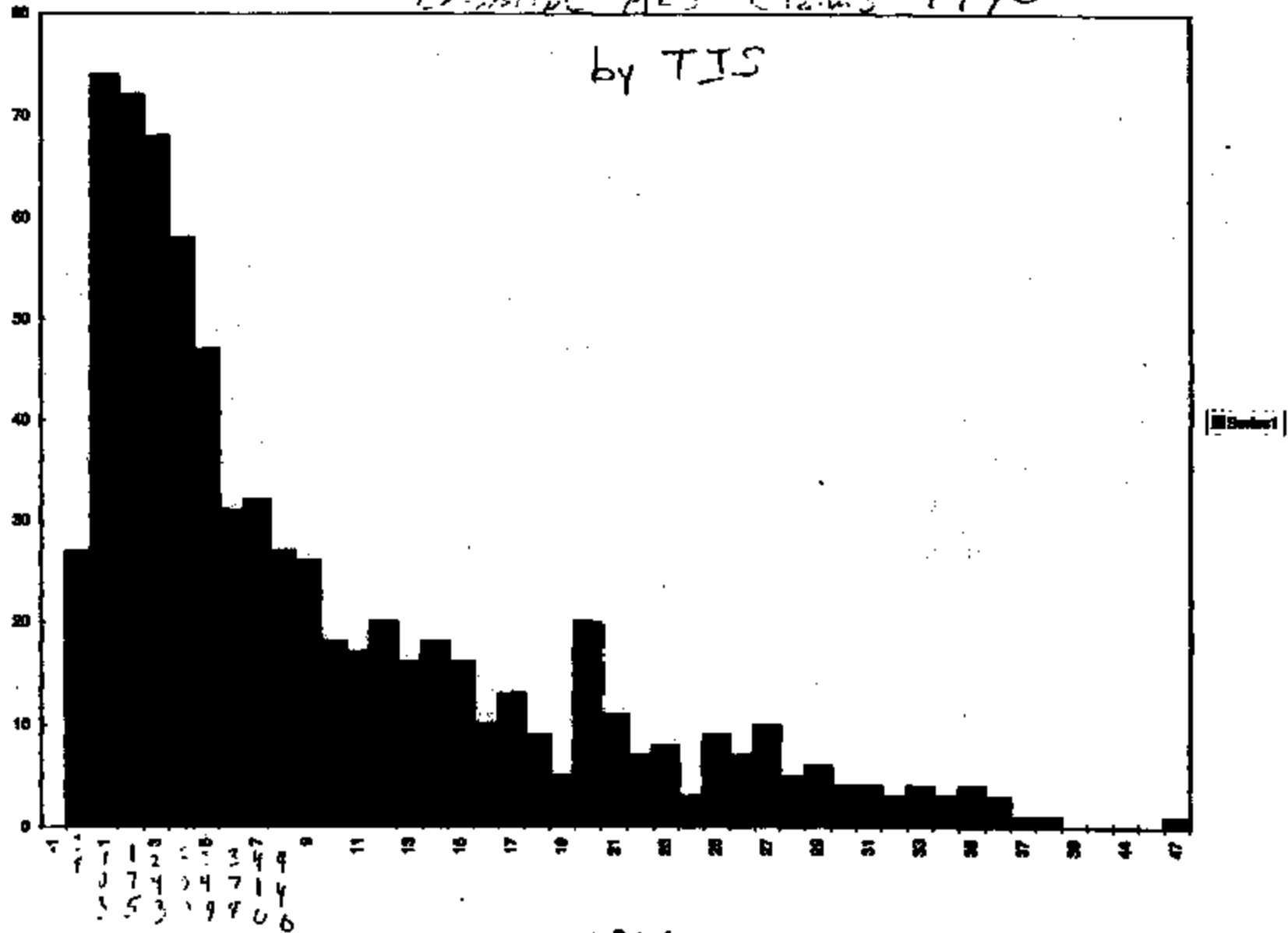
4

C

HIT
BLAKE
11/10/16

Expenditure A25 Claims 1993

by TIS



Texas Instruments Incorporated
8-D Problem Resolution Report # PS/CAR/93-3

CLOSED 12/1/93

Original Report: July 29, 1993
Update Report: October 18, 1993
Ford Part Number: F3TA-9F924-AA/BA/CA
Part Description: Speed Control Deactivation Switch

(STEP 1) PRODUCT TEAM

Manufacturing Engineering: Matt Sellers
Quality Assurance Engineering: Jim Watt
Product Marketing: Charlie Douglas
Design Engineering: Aziz Rahman (Champion)

(STEP 2) PROBLEM DESCRIPTION

Ford Light Truck Division Brake Engineering reported a noticeable increase in warranty returns, related to inoperative speed control systems for 1993 Econoline models during 4QTR'92 and 1QTR'93 time frame. Detailed breakdown of warranty data showed that a number of these claims were reported to be pressure switch related. Attachment "A" shows R/1000 data as collated from Ford warranty data. Texas Instruments and Ford started on 7/22/93 to call dealerships from the Master Claim list contacting over 150 dealerships. As of 10/18/93, (14) switches have been received, analyzed, and characterized.

The following table details the field data on these switches:

VID	Vehicle type	Switch date code
---	-----	-----
A84642	'93 Econoline	2316 (November '92)
A35294	'93 Econoline	2294
A40855	'93 Econoline	3078
A70383	'93 Econoline	2345
A61611	'93 Econoline	2345
A34137	'93 Econoline	2243
A32248	'93 Econoline	2286
A47374	'93 Econoline	2307
A50451	'93 Econoline	2316
A49359	'93 Econoline	2338
A57954	'93 Econoline	2345
A92609	'93 Econoline	3037
B15536	'93 Econoline	3078
A40855	'93 Econoline	3175

(13) switches were confirmed to be inoperative switches due to liquid ingress resulting in severe corrosion. Switch with date code 2307 was operating normally.

(STEP 3)

INTERIM CONTAINMENT ACTION

We have completed the following actions in assessing the integrity of our current product:

1. Verified environmental seal integrity and proper function.
2. Verified switch connector base dimensions that could affect the mating connector sealing ability to be within specification.

Based upon Texas Instruments' verification of the critical connector base dimensions, the functionality of the environmental seal, and observation of fluid ingress into the switch cavity through the terminal blades, an analysis/investigation of the mating connector sealing system is warranted.

3. Texas Instruments, in cooperation with Ford Light Truck Engineering, conducted a water ingress test with various component combinations of the mating connector, to determine relative susceptibility of each combination. The following combinations were tested:

Current Light Truck -----	Light Truck Before 11/92 -----	Current Pass Car -----
Black UTA shell	Black EPC shell	Black UTA shell
Gray Grommet	Gray Grommet	Gray Grommet
Red Silicon Seal	Red Sponge Seal	Red Sponge Seal

The matrix of components tested and the test sequence is outlined in attached charts. Preliminary data analysis did not show significant differences amongst various matrix elements. It has been concluded that the switches need extended exposure under shower to initiate water ingress. In addition to the above combination of components, 50% of the switches were tested with a "rocked" connector.

The shower test was halted on 10/6/93, when non-normal insulation resistance readings were observed on rocked switches. Upon removal of the connectors, water ingress was observed on all switches with rocked connectors. There was no ingress on correctly latched switches. The attached Table 1 summarizes the matrix of parts and visual observations. The ingress in vertical switches was of a magnitude higher than in horizontal switches. Photographs of the switches were sent to Ford Light Truck Engineering for review. The switches were calibrated for functionality. The attached Table 2 confirms the effect of ingress as seen in the reduction of insulation resistance and intermittent operation of the switches. The switches were then disassembled for internal inspection. It was observed that the ingress had proceeded through the connector cavity into the contact zone. Photographs are attached.

The ingress activity on the rocked switches was similar to that observed on parts returned from the field, albeit of a lesser magnitude. It is believed that, given sufficient time (to allow current to pass through the contacts), the ingress on the rocked switches would exhibit exactly the same failure as that observed on the warranty parts.

(STEP 4) ROOT CAUSE

The switches analyzed were inoperative since there was no electrical continuity between the terminals. Attachment "B" shows the fishbone diagram for a stuck open switch. The lack of continuity was due to presence of large amounts of corrosion products inside the switch cavity and, in some cases, failure of contact elements due to corrosion. The large quantity of corrosion products is due to fluid that entered the switch cavity. Because of the severe amount of corrosion observed, it is believed that the corrosion is accelerated by the potential difference between the grounded body of the switch and current carrying members.

Thorough visual observation concluded the fluid entry to be through the mating connector end of the switch as evidenced by brass corrosion products along the terminal blades in the connector cavity (see attached photographs). Two of the switches exhibited blue/green corrosion by-products covering more than one half of the connector cavity. The others showed similar corrosion products but in lesser amounts. None of the switches showed any evidence of fluid ingress by the environmental seal.

The snap acting disc in all the returned switches was functioning normally.

The following observations were made by Texas Instruments on '93 Econoline and F-Series Trucks at a local Ford dealership:

1. Econoline: The wire leads coming out of the switch were routed below and touching the rear A/C line. This will create a propensity for water/condensation traveling along the line to flow along the wire leads to the grommet.
2. F-Series: The observed vehicles had a Red Sponge seal inside the mating connector, as opposed to the expected Red Silicone seal.

Additional observations regarding face seal variations:

1. The target zone for pressure switch sealing surface is smaller on the sponge seal, than the silicone seal. The smaller target zone, may lead to a sub-optimal sealing condition under worst case dimensional stack-up.

2. It has been seen that during the mating connector assembly process, there is an opportunity for the silicone seal to be rolled over. This can happen during insertion of the plastic terminal separator. The insertion is done after the silicone seal is placed in the plastic shell. A rolled over silicone seal would not provide protection against water ingress.

3. The silicone seal, by design, has a lower percent compression than the sponge seal. The design limits for the silicone seal are 10 - 15%, whereas the limits for the sponge seal are 38 - 50%. The reduction in percent compression was intended to maintain similar loading forces. It has been observed that there is a tendency for the mating connector to 'rock' in the latched position. The rocking tendency would lead to a higher percent change in the level of compression of the silicone seal than on the sponge seal.

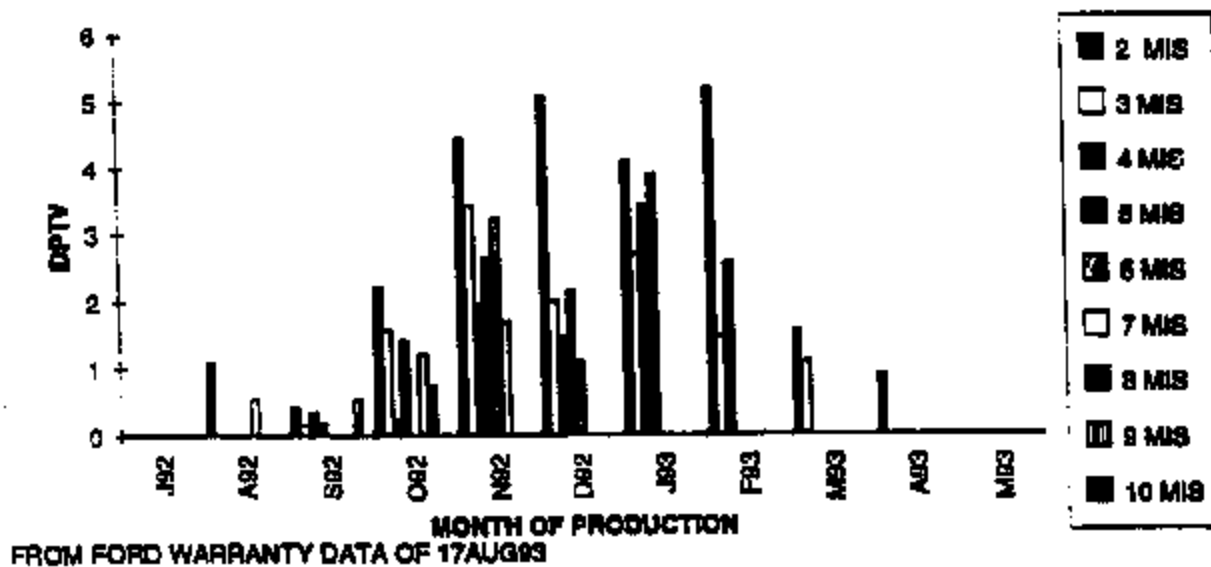
The shower test detailed above, leads to the conclusion that a "rocked" connector was the most probable root cause of the observed problem. The impact of the problem is magnified in the Econoline platform due to the mounting location and vertical mounting position, both of which are unfavorable from an ingress point of view.

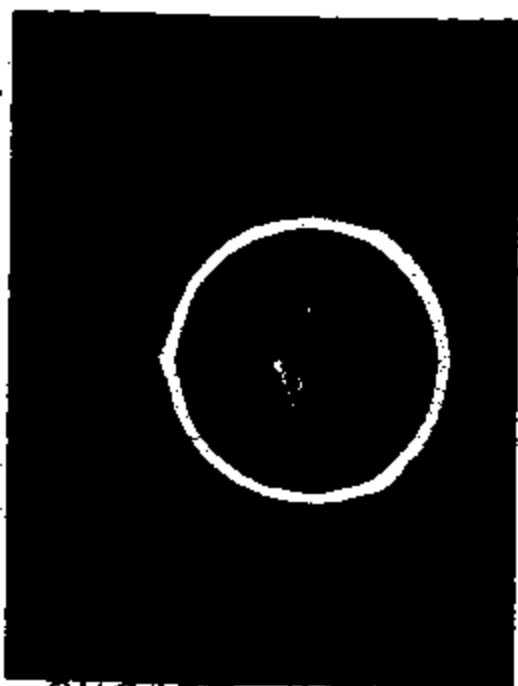
(STEP 5) PERMANENT CORRECTIVE ACTION

No corrective action is required from Texas Instruments at this point.

(STEP 6) VERIFY CORRECTIVE ACTION

(STEP 7) PREVENT RECURRENCE

93 ECONOLINE



A40855 DC3078A



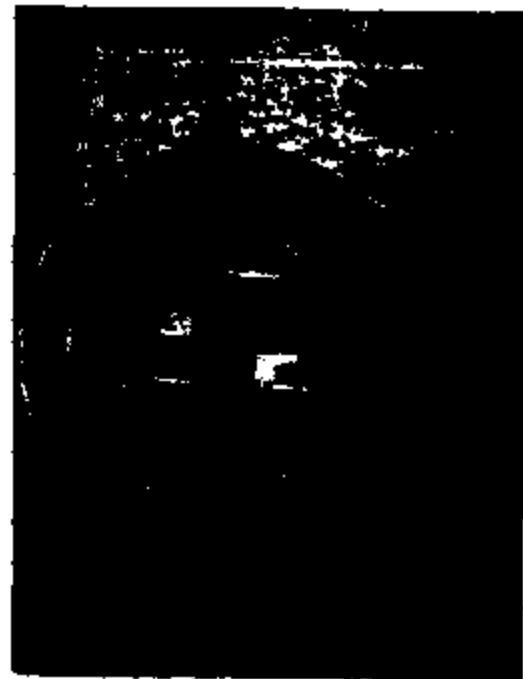
A40855 DC3078A



A40855 DC3078A



A35294

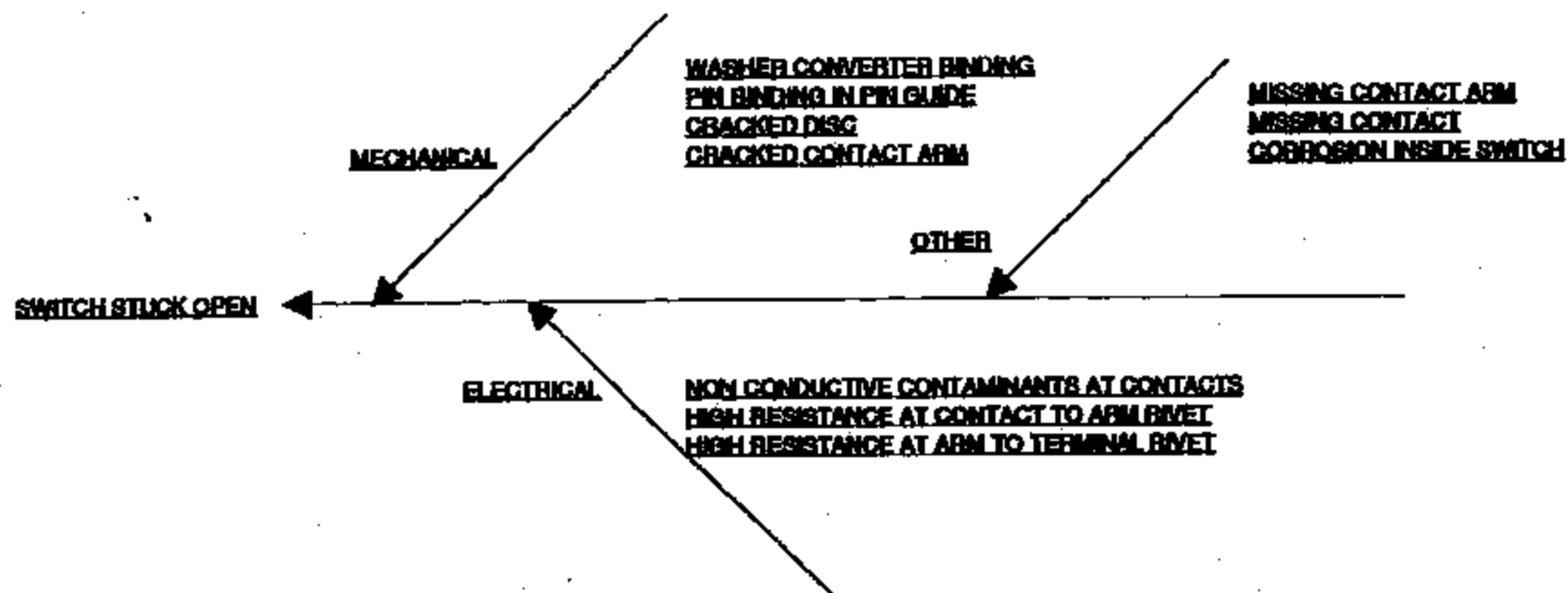


A35294



A35294

ATTAC. NT 'B'



3713 2004

connector system matrix for shower test		6/17/93				
	a	b	c	d	e	f
shell	uta	uta	uta	uta	epc	epc
groenmat	gray	gray	gray	gray	gray	gray
face seal	sponge	sponge	silicone	silicone	sponge	sponge
wire leads	elect	tension	elect	tension	elect	tension
orientation	horizontal	horizontal	vertical	vertical	vertical	vertical
content	pass-car/bronco	pass-car/bronco	econoline	econoline	econoline	econoline
# of switches	2	2	2	2	2	2

3713 2005

77PBL3-3 CONNECTOR MATRIX SHOWER TEST

8/12/73

POWER: 13 VDC, 750 mA
P-CYCLE: 0-350 psig

PRE TEST MEASUREMENTS
ACT/REL/MV DROP/CNTCT RES/INS RES

SHOWER START
10 P-CYCLES

30 MIN

SHOWER STOP
MV DROP/CNTCT RES/INS RES

SHOWER START
10 P-CYCLES

30 MIN

SHOWER STOP
MV DROP/CNTCT RES/INS RES

SHOWER START
10 P-CYCLES

1 HR

SHOWER STOP
MV DROP/CNTCT RES/INS RES

SHOWER START
10 P-CYCLES

1 HR

SHOWER STOP
MV DROP/CNTCT RES/INS RES

POST TEST MEASUREMENTS
ACT/REL/MV DROP/CNTCT RES/INS RES

VISUAL INSPECTION

3713 2006

77PSL3-3 SHOT. TEST- RAW DATA 8/23/83

SW. #	PRE-TEST		C-RES	I-RES	MV DR.	30 MIN			60 MIN			120 MIN			420 MIN		
	ACT	REL				C-RES	I-RES	MV DR.	C-RES	I-RES	MV DR.	C-RES	I-RES	MV DR.	C-RES	I-RES	MV DR.
A1	253	183	4.4	0.1	NA	29.5	0.1	NA	52.8	0.1	NA	41.9	0.1	NA	37.7	0.1	NA
A2	253	180	4	0.1	NA	31.4	0.1	NA	54.7	0.1	NA	43.8	0.1	NA	39.6	0.1	NA
B1	235	179	4.5	0.1	NA	29.5	0.1	NA	52.8	0.1	NA	41.7	0.1	NA	37.4	0.1	NA
B2	263	187	4.3	0.1	NA	25.3	0.1	NA	48.7	0.1	NA	37.7	0.1	NA	33.9	0.1	NA
C1	228	175	4	0.1	NA	32.4	0.1	NA	13.8	0.1	NA	44.7	0.1	NA	36.9	0.1	NA
C2	261	187	4.3	0.1	NA	16.1	0.1	NA	39.1	0.1	NA	24.9	0.1	NA	22.7	0.1	NA
D1	246	177	4	0.1	NA	30.1	0.1	NA	63.7	0.1	NA	42.7	0.1	NA	40.2	0.1	NA
D2	258	183	4.2	0.1	NA	25.4	0.1	NA	41.6	0.1	NA	37.6	0.1	NA	41.1	0.1	NA
E1	242	191	4.4	0.1	NA	33.8	0.1	NA	57.3	0.1	NA	48	0.1	NA	41.5	0.1	NA
E2	255	193	4.3	0.1	NA	29.1	0.1	NA	52.9	0.1	NA	38.8	0.1	NA	39.6	0.1	NA
F1	249	184	4.1	0.1	NA	36.2	0.1	NA	60.3	0.1	NA	48.5	0.1	NA	42.8	0.1	NA
F2	237	182	6.6	0.1	NA	31.1	0.1	NA	55.5	0.1	NA	43.9	0.1	NA	36.7	0.1	NA
NA - GREATER THAN 20 MEGAOHMS																	

Table 1

FSTA-8F924-CA SPEED CONTROL DE-ACTIVATION SWITCH							10/9/93							
T.I. PIN		77P813-3												
UPDATE OF RESULTS FROM SHOWER TEST														
HOURS OF EXPOSURE TO DATE:				324										
		a		b		c		d		e		f		
shell	ula	ula		ula		ula		ula		epc		epc		
ground	gray	gray		gray		gray		gray		gray		gray		
face seal	sponge	sponge		silicone		silicone		silicone		sponge		sponge		
wire leads	tension	slack		tension		slack		tension		slack		vertical		
orientation	horizontal	horizontal		vertical		vertical		vertical		vertical		vertical		
comment	pass-car/bronco	pass-car/bronco		econoline		econoline		econoline		econoline		econoline		
latching	a1	a2	b1	b2	c1	c2	d1	d2	e1	e2	f1	f2		
	latched	rocked	latched	rocked	latched	rocked	latched	rocked	latched	rocked	latched	rocked		
results	o.k.	ingress	o.k.	ingress	o.k.	ingress	o.k.	ingress	o.k.	ingress	o.k.	ingress		
		(minor)		(minor)		(major)		(major)		(major)		(major)		

3713 2009

Table 2

F31A-2F324-CA SPEED CONTROL DE-ACTIVATION SWITCH						10/18/93	
T.L P/N	77P8L3-3						
RESULTS FROM SHOWER TEST							
HOURS OF EXPOSURE TO DATE:				324			
SWITCH #	ACT	REL	RTN DROP	TERM TO TERM @ 300 PSI	TERM TO CASE 500 VDC MEGGER	CONNECTOR STATUS	INGRESS
A1	200	182	4	> 20 MEGA-OHM	64 GIGA-OHM	LATCHED	NONE
A2	242	178	4	"	100 GIGA-OHM	ROCKED	MINOR
B1	238	172	4.2	"	68 GIGA-OHM	LATCHED	NONE
B2	208	185	4.2	"	50 GIGA-OHM	ROCKED	MINOR
C1	238	174	4	"	120 GIGA-OHM	LATCHED	NONE
C2	200	182	6.8	22.3 KILO-OHM	1.3 MEGA-OHM	ROCKED	MAJOR
D1	248	179	4.3	> 20 MEGA-OHM	130 GIGA-OHM	LATCHED	NONE
D2	285	188	4.1	25.4 KILO-OHM	3.7 MEGA-OHM	ROCKED	MAJOR
E1	257	182	4.1	> 20 MEGA-OHM	110 GIGA-OHM	LATCHED	NONE
E2	280	190	4.2	"	2.25 MEGA-OHM	ROCKED	MAJOR
F1	253	182	4	"	107 GIGA-OHM	LATCHED	NONE
F2	200	182	4	51.3 MEGA-OHM	< 1 MEGA-OHM	ROCKED	MAJOR
- INTERMITTENT ACTUATION							



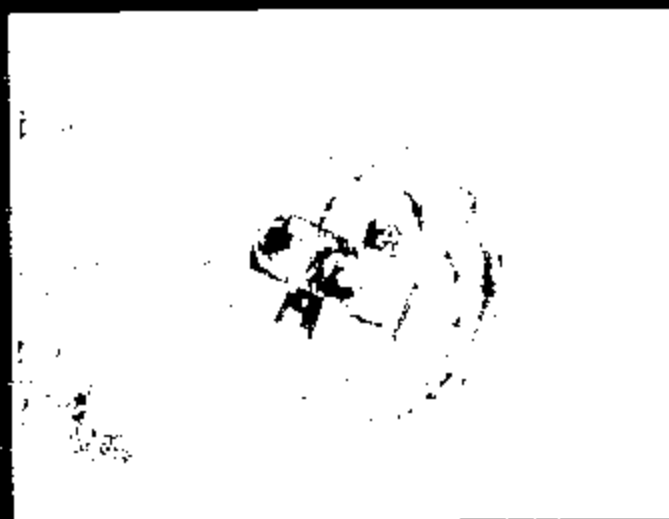
C8



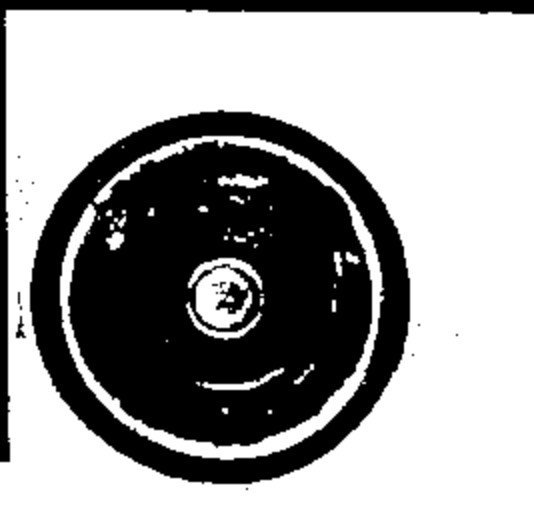
E2



E2



F2



F2

3713 2010

WERS HARDCOPY PARAMETER RECAP

BASIC PARAMETERS

REQUESTOR: RHIMERS, STEVE
 REQUEST DATE/TIME: 99/04/13 12:03:15
 REPORTS REQUESTED FOR: RHIMERS, STEVE
 DESTINATION DEVICE: R02043M7
 PRINT DATE/TIME: 99/04/13 12:03:15
 DATA EXTRACT DATE/TIME: 99/04/13 12:03:14

REPORT OPTIONS

HARD-COPY REQUEST-TYPE: ON-LINE REQUEST(LATEST DATA)
 LANGUAGES: ENGLISH
 PART DATA RESTRICTIONS:
 NONE

SELECTION CRITERIA

NOTICE NUMBER:
 PART NUMBER:
 PART FUNCTION:
 CONCERN NUMBER: C10190755

REPORTS REQUESTED

RELEASE / CONCERN COVER	USAGE TRANSLATION SHEET
RELEASE SUMMARY	CONTENTS OF ASSEMBLY - SAN ONLY:
RELEASE CHANGE SUMMARY	X CONCERN DETAIL
PART FUNCTION RELEASE	ALERT DETAIL
MULTI-FUNCTION RELEASE	

CONCERN DETAIL

PRINT DATE/TIME: 99/04/13 12:03
PAGE: 1

CONCERN NUMBER
C10190755

ORIGIN ACTIVITY
ORIGINATOR: EL00 LIGHT TRUCK PRODUCT
BARUKAR, ANIL E.

DATE: 92/02/04
PHONE: (313)337-2702

P MNT AUTH:A
STATUS: C

LOCAL: N
LOCATION: 1109 BLDG #1
FLX PFM: N

CONCERN DESC: PRESSURE SWITCH FOR DEACTIVATION OF NEXT GUN SPEED CONTROL
DESCRIPTION: HAS FAILED SALT SPRAY PORTION OF THE FORD-14A464-AA BACE
SOLUTION: CONNECTOR SPECIFICATION (SECTION 2A).

PRODUCTS AFFECTED: ALL 1992 AND 1993 MY VEHs WITH NEXT GUN SPEED CTRL.
MODEL CODES: ORIG
MCC:
MCC:

PLANTS AFFECTED: MAU7
PRIMARY ENG ACTY: MB00

OTHER ENG ACTY: MB00 MLT4 EL00 MA01 ML71

BUILD EVENT: N N
CPSC:
PSO:
REQUIRE BY:
SUPPORTING DOCUMENTS:
AUTHORIZED DATE: 92/06/08

CONDITION CODES:
PACK:
PRIORITY CODES: 3
1 PP SUPT W/PARTS TO PROD INTENT
CONCURRED DATE: 92/06/19

MODEL YEAR: 92
MCC MODEL YEAR: 93
MCC:
MCC: NLE1

CONCUR:
CAUSAL FACTORS:
%:
NOTICE NO:
OVERALL ACH DATE:
REJECTED DATE: 00/00/00

ORIGINATOR'S ESTIMATES:

VEHICLE COST:
WARRANTY COST:
TOW:
TOOLING COST:
VEH WGT:
ASSEMBLY MIN:

ASSEMBLY LABOR:
UNIT OF MEASURE:

FACILITY COST:
R/1000:

*****AFFECTED PARTS*****

APP PART NO:
CPSC:
SUPPLY/LOCAL:
APP PART DESC:
NOTICE:
DAMAGE AVAIL:

*****FURTHER DESCRIPTION/CONCERN RESOLUTION/REASON FOR REJECTION ETC.*****

DESCRIPTION: PRESSURE SWITCH FOR DEACTIVATION OF NEXT GUN SPEED CONTROL
HAS FAILED SALT SPRAY PORTION OF THE FORD-14A464-AA BACE
CONNECTOR SPECIFICATION (SECTION 2A).
BARUKAR, ANIL E N K4513 ARS1905 EL00 92/02/04
AL BARUKAR X72702
BARUKAR, ANIL E N K4513 ARS1905 EL00 92/02/04
PRESSURE SWITCH AND CONNECTOR ASSEMBLY FAIL TO MEET FORD
SPECIFICATION (SWITCH BODY - SPEED CONTROL DEACTIVATE
RS-F2VC-9F924-AA) FOR SALT SPRAY TESTING. THE TEST CONSISTS
OF PLACING 6 SWITCH ASSEMBLIES W/CONNECTOR INTO A SALT SPRAY
ENVIRONMENT PER ASTM B-117 FOR 72 HOURS. FOLLOWING THE
TEST, THEY MUST PASS CALIBRATION, VOLTAGE DROP, CURRENT
LEAKAGE, AND PROOF PRESSURE TESTS FOR ACCEPTANCE. SALT
RESIDUE / FLUID INCREASE WAS FOUND IN THE TERMINAL CAVITY OF

(CONTINUED)

-MORE-

CONCERN DETAIL

PRINT DATE/TIME: 99/04/13 12:03
PAGE: 2

CONCERN NUMBER
C10190755

ORIGIN ACTIVITY
ORIGINATOR:

ML00 LIGHT TRUCK PRODUCT
SANKAR, ANIL K.

DATE: 92/02/04
PHONE: (313)337-2702

P NOT AUTH:A
STATUS: C

*****FURTHER DESCRIPTION/CONCERN RESOLUTION/REASON FOR REJECTION ETC.*****

DESCRIPTION:

THE FAILED DEVICES. ALL DIMENSIONS ON THE SWITCH HALF OF THE CONNECTOR ARE WITHIN PRINT SPECIFICATION. THE CONCLUSION IS THAT THE WIRING CONNECTOR HALF IS NOT CAPABLE OF PROVIDING A GOOD SEAL. AS A POSSIBLE SOLUTION, CHANGING TO THE PASSENGER CAR VERSION OF THIS CONNECTOR (UNITED TECH VERSION) WOULD BE A MEANS FOR PASSING THE SPECIFICATION SWITCH PASSING THE MS SPEC. WITH THIS VERSION OF CONNECTOR USED ON PASSENGER CAR SPEED CONTROL VEHICLES. THIS COULD BE A WORKING CHANGE FOR 1992. FOR 1993 JOB #1, USING CONNECTOR F31B-14AA64-UA WOULD YIELD IMPROVED RESULTS. ALERT A10168588 HAS BEEN ISSUED TO WAIVE THE GALT SPRAY REQUIREMENTS OF THE TEST SINCE THE SWITCH IS DIMENSIONALLY CAPABLE.

PRILEY, J.A. (JON X45928 N K4513 JAF1648 ML00 92/02/05

THE NEW CONNECTOR (F31B-14AA64-UA) MUST MEET THE FOLLOWING REQUIREMENTS: IT MUST BE CAPABLE OF SEALING UNDER 1 FOOT OF WATER, IT MUST PASS THERMAL SHOCK TESTING, AND IT MUST BE PASS WATER SPRAY TESTING.

AJ SANKAR X72702

SANKAR, ANIL K N K4513 AHS1905 ML00 92/02/07
CONCERN SHOULD BE ACCEPTED FOR INVESTIGATION THE BACK IS DESIGN RESPONSIBLE ACTIVITY FOR WIRING SIDE OF THE CONNECTOR ASSIGN CONCERN TO BACK.

MORI, WERN E. (313) 32-31442 N K4513 NEM4640 ML00 92/02/11

TERRY, PLEASE ASSIGN TO BACK. AJ SANKAR X72702

SANKAR, ANIL K N K4513 AHS1905 ML00 92/02/22

DEVELOPMENT TEST CONCERN ADDED TO J41-93 PINK FOR INVESTIGATION AND ROUTED TO REPOTRY (BUT) AND DON HAKKARD FOR PROGRAM MANAGEMENT APPROVAL. *** G. HASBURY

* THERE IS NO LONGER VALID * N K4541 GM7383 ML00 92/02/26

*** K5180 RECEIVED THIS CR FOR THE FIRST TIME IN 'I' STATUS ON 2-27/83

ELECTRICAL DIST 313-39-04362 N K5180 K5180 ML00 92/02/27

***** SUN, PLEASE CLOSE TO K5180, VES8 WIRING. THIS IS A CORP; SUN, DISREGARD ABOVE COMMENT.

***** ROUTE TO ELECTRONICS FOR CONCURRENCE, RESOLUTION, TYPING, PIECE PRICE, R/1880, TOOLING AND WEIGHT AFFECT.

***** B. PAPPAS N & C E WIRING *****
* THERE IS NO LONGER VALID * N K5182 BP9430 ML00 92/03/02

ELECTRONICS NEEDS SOMETHING TO ADD THE CURRENT PASSENGER CAR

(CONTINUED)

-MORE-

CONCERN DETAIL

PRINT DATE/TIME: 99/04/13 12:03
PAGE: 3

CONCERN NUMBER
C10190755

ORIGIN ACTIVITY
ORIGINATOR:

BL00 LIGHT TRUCK PRODUCT
SAHUKAR, ANIL E.

DATE: 92/02/04
PHONE: (313)337-2702

P NEXT AUTH:A
STATUS: C

*****FURTHER DESCRIPTION/CONCERN RESOLUTION/REASON FOR REJECTION ETC.*****

DESCRIPTION:

CONNECTOR PART NUMBER INTO THE CR. WE CURRENTLY USE PART #
E88B-14A464-CCA ON THE ECMOLINE. IS THERE A COST VARIANCE
THAT NEEDS TO BE ADDRESSED WITH THE PASSENGER CONNECTOR? WHO
APPROVES OF RUNNING CHANGE FOR 1992? I THOUGHT ALL RUNNING
CHANGES WERE NO LONGER ACCEPTED. WILL COST PART NUMBER
F31A-14A464-DA FOR 1993 AND WILL WALK ESTIMATE INTO THE
ELECTRICAL PWT FOR APPROVAL. WILL NEED INFORMATION REQUESTED
ABOVE TO ADDRESS ISSUE FOR 1993 RUNNING CHANGE.

*** M. SPURGEON ELECTRONICS

***** ROUTE TO R. PATTAS *****

ELECTRONICS (VN 313-336-9393 C 7826 EFFPES2

111 SUN, PLEASE ROUTE TO THE CONNECTOR SECTION. (BOB HAYWARD
AND LEAHY GILPIN) L. WENSHAY

OLD WENSHAY, LA 313-39-04366 N RS183 LEM0118

***BRIE, THIS SHOULD NOT BE A 92 RUNNING CHANGE. IT MUST
BE WALKED INTO THE CHANGE CONTROL MEETING FOR 94 INCLUSION.
PLEASE PUT YOUR STANDARD COMMENT TO THE ORIGINATOR AND SEND
BACK TO HIM. THANKS. DALE REINHARDT.73158*****

HARRARD, R.M. (313) 39-08591 N K4556 RHM0045

***REMOVED FROM 92 RUNNING CHANGE PINK REPORT PER ABOVE
COMMENTS FOR ECMOLINE. FORWARDED TO ORIGINATOR TO WALK
IN TO 94 JOB 1 PINK REPORT MEETING ON MONDAY OR WEDNESDAY,
BL00 INTERMED CONF. ROOM AT 9:00 AM. IF NOT WALKED IN
WITHIN TWO WEEKS THIS CONCERN WILL BE REJECTED. *S. SOLOWAY

* THERE IS NO LOWER VALID * N K4641 GW7383

**IF THIS IS A '94 CHANGE, THEN LT ELECTRICAL QUESTIONS
THE NEED TO GO TO A MORE EXPENSIVE CONNECTOR (IF IT IS
MORE EXPENSIVE), SINCE THE NEW LOCATION ONLY NEEDS TO
BE FLASHPROOF VS SUBMERSIBLE. T. RODGERS***

RODGERS, T.A. (313) 33-75845 N K4535 TAE2503

BACK - WHAT IS THE PROJECTED INCIDENCE OF WATER INTRUSION IN
THE CURRENT LOCATION? CAN WE AFFORD TO WAIT UNTIL 1994 TO
FIX THIS PROBLEM? PLEASE NOTE THAT FIELD WARRANTY ON SPEED
CONTROL WILL ONLY INDICATE THOSE CONNECTORS THAT HAVE FAILED
THE SWITCH IN THE SHORTED POSITION. CONNECTORS THAT LEAK
AND CAUSE SUBSEQUENT TERMINAL CORROSION WILL NOT BE DETECTED
BY SPEED CONTROL WARRANTY AS THE SWITCH IS NORMALLY OPEN.
HAS YEAR DONE OF THE CONNECTORS FROM DURABILITY TESTING BEEN
DONE TO LOOK FOR SALT/WATER TRACES IN THE CONNECTOR?

AJ SAHUKAR K72782

SAHUKAR, ANIL E N K4513 ARI1905
CORRECTION TO THE ABOVE. THE SWITCH IS NORMALLY CLOSED. IF

(CONTINUED)

-MORE-

CONCERN DETAIL

PRINT DATE/TIME: 99/04/13 12:03
PAGE: 1

CONCERN NUMBER
C10190755

ORIGIN ACTIVITY
ORIGINATOR:

HL00 LIGHT TRUCK PRODUCT
SAHUKAR, ANIL E.

DATE: 92/02/04
PHONE: (313)337-2702

P MGT AUTH:A
STATUS: C

-----FURTHER DESCRIPTION/CONCERN RESOLUTION/REASON FOR REJECTION ETC.-----

DESCRIPTION:

ANY WATER INTRUSION OCCURS, NO SHORT CAN BE DETECTED -
ALREADY CLOSED BY DESIGN. THE CONNECTOR FAILS A "SIMPLY"
SALT FOG TEST.

TO SUMMARY: THE CONNECTOR IS NOT
CAPABLE OF SEALING. THERE IS NO WAY OF DETECTING FAILURE.
RECOMMEND AN IMPROVED CONNECTOR BE INCORPORATED.

JOHN PELKEY, LTR BRAKE ACT/ABS, I46928
PELKEY, J.A. (JON I46928 N K4513 JAP3640 HL00 92/03/09
***** ELECTROWIRE, THE PART NUMBER IS DESIGNATED IN THE CON
CERN. PLEASE RESPOND WITH DATE AT WHICH CONCERN WILL BE WALK
ED INTO HWY, OCC, AND ADV POL DATE IF ACCEPTED BY OCC.

***** B. PAPPAS B & C WIRING *****
* USER IS NO LONGER VALID * N K5183 BP9620 MD00 92/03/10

HILL, ELECTROWIRE IS UNABLE TO OBTAIN THE F3LB-14A464-0A
COST INFORMATION FROM SUPPLIER UTA. WE CANNOT DEVELOP A
COST ESTIMATE FOR THE WIRE HARNESS AFFECT TO WALK INTO
CHANGE CONTROL. DOES BODY ENGINEERING HAVE ANY COST INFO?
PLEASE INFORM.

N. SPURGEON ELECTROWIRE
***** ROUTE TO N. PAPPAS *****
ELECTROWIRE (VN 113-336-9393 C 7026 BP9620 MD00 92/03/10

***** SUB, PLEASE CLOSE THIS CONCERN TO K5183 VMS. THIS
CONNECTOR HAS SUPPOSEDLY PASSED ALL BODY ENGINEERING TESTS
FOR SUBMERSIBILITY, THEREFORE IT IS USED ON OUR WIRE HARNESS.
IF CHANGES TO THE WIRE HARNESS ARE REQUIRED THEN DIRECTION
FROM CONNECTOR ENGINEERING IS REQUIRED. GUS, PLEASE ROUTE TO
R. HAYWARD OR L. GILPIN OF CONNECTOR ENGINEERING FOR RESOLUTI
ON OF CONCERN.

***** B. PAPPAS B & C WIRING *****
* USER IS NO LONGER VALID * N K5183 BP9620 MD00 92/03/11

LTR BRAKES HAS HAD IT (TEXAS INSTRUMENTS) RUN SALT FOG AND
THE CONNECTOR HAS FAILED. I FIND IT DIFFICULT TO BELIEVE
THAT A COMPONENT FAILING SALT FOG PASSES THE SUBMERSIBLE
SPECIFICATION. FURTHER, BOB HAYWARD HAS INDICATED TO US THAT
THIS CONNECTOR IS NOT SUBMERSIBLE. IF YOU HAVE DIFFERENT
INFORMATION, PLEASE PROVIDE LTR BRAKES WITH THE DV OR PV DATA
SHOWING THAT BS-P08B-14A464-0A HAS, IN FACT, BEEN PLOTTED
WITH THE CURRENT CONNECTOR.

SAHUKAR, ANIL E
AJ SAHUKAR X72702 N K4513 AB91905 HL00 92/03/12

THE F3LB-14A464-0A CONNECTOR IS A SLIGHT COST SAVINGS
COMPARED TO BS9B-14A464-CCA. IT IS RECOMMENDED THAT THE
F3LB-14A464-0A BE SPECIFIED FOR THIS PRESSURE SWITCH.
RON F. FRANTS X04370

(CONTINUED)

-MORE-

CONCERN DETAIL

PRINT DATE/TIME: 99/04/13 12:03
PAGE: 5

CONCERN NUMBER
C10190756

ORIGIN ACTIVITY
ORIGINATOR:

HL00 LIGHT TRUCK PRODUCT
BARBER, AMIL E.

DATE: 92/02/04
PHONE: (313)337-2703

P NRY AUTH:A
STATUS: C

*****FURTHER DESCRIPTION/CONCERN RESOLUTION/REASON FOR REJECTION ETC.*****

DESCRIPTION:

OLD-PROATS, R.F. 313-39-04370 M K5370 RFF7473 MB00 92/03/13
**PLEASE NOTE CONCERN TO G. RANDALL FOR INPUT ON CUSTOMER
SPEED CONTROL OPERATION ISSUES W/ PRESENT DESIGN. VMS
DURABILITY DATA INDICATES NO ISSUES ON SP/VP HARNESSES.
RECOMMEND INCLUSION AT '94 IN DEPENDENT ON SPEED CONTROL
WARRANTY ISSUES.
T. RODGERS***
RODGERS, T.A. (313) 33-75846 M K4535 TAR2503 ML00 92/03/13

IT IS TOO EARLY TO SEE CORROSION FAILURE YET, AND TO DATE
WARRANTY CLAIMS INDICATE THAT THE ONLY CONCERN IS FAILURE
OF THE PLANT TO LOCK UP THE CONNECTOR.
G. RANDALL
* USER IS NO LONGER VALID * M K4534 GCR8815 ML00 92/03/13
***** ELECTROWIRE, THIS CONCERN HAS BEEN RECOMMENDED BY THE
CONNECTOR ENGINEER. THERE IS NO COST INCREASE SO PLEASE TAKE
INTO CHARGE CONTROL AS A NO COST AND PROCESS!
***** B. PAPPAS B & C E WIRING *****
* USER IS NO LONGER VALID * M K5183 BP9630 MB00 92/03/13
ELECTROWIRE WILL WALK INTO CHARGE CONTROL ON 3/20/92 FOR
APPROVAL. WILL ADV PCI ONCE APPROVED. W. SPURKIN WWP
***** ROUTE TO B. PAPPAS *****
ELECTROWIRE (VM 313-336-9393 C 7026 ENPVN58 G026 92/03/13
***** CONCERN, AWAITING APPROVAL.
***** B. PAPPAS B & C E WIRING *****
* USER IS NO LONGER VALID * M K5183 BP9630 MB00 92/03/16

TO FURTHER SUPPORT MY PREVIOUS COMMENTS, THIS CHANGE NEEDS
TO BE "QUICKLY". THESE COMPONENTS MUST WORK PROPERLY
FOR THE SPEED CONTROL SYSTEM.
G. RANDALL K24391

* USER IS NO LONGER VALID * M K4534 GCR8815 ML00 92/03/16
ELECTRO-WIRE PRESENTED COST TO CHANGE CONTROL ON 3-20-92.
DALE WERNHART DID NOT APPROVE AND IS INVESTIGATING CHANGE.
ELECTRO-WIRE WILL NOT PROCEED UNTIL PROGRAM MANAGEMENT
APPROVES THIS CONC. DEAN SHELL (JMP)*****

ELECTROWIRE (VM 313-336-9393 C 7026 ENPVN58 G026 92/03/24
***** NO WIRING CHANGES WILL BE DONE FOR THIS CONCERN UNTIL
PROGRAM MANAGEMENT APPROVAL IS GIVEN. BUN, PLEASE CLOSE THIS
CONCERN TO K5183 VMS. NO CHANGES CAN BE DONE UNTIL APPROVA
L IS GIVEN.
***** B. PAPPAS B & C E WIRING *****
* USER IS NO LONGER VALID * M K5183 BP9630 MB00 92/03/27

-MORE-

CONCERN DETAIL

PRINT DATE/TIME: 99/04/13 12:03
PAGE: 6

CONCERN NUMBER
C10190755

ORIGIN ACTIVITY
ORIGINATOR:

HL00 LIGHT TRUCK PRODUCT
SAHUKAR, ANIL K.

DATE: 92/02/04
PHONE: (313)337-2702

F MGT AUTH:A
STATUS: C

*****FURTHER DESCRIPTION/CONCERN RESOLUTION/REASON FOR REJECTION ETC.*****

DESCRIPTION:

**ROUTED TO R. HAZARD/D. BERNHARDT FOR UPDATE ON STATUS
AS TO WHETHER WE CAN AUTHORIZE FOR ECONOMLINE OR REJECT
CONCERN.
**S. SOLOWAY I73664

* USER IS NO LONGER VALID * N K4641 SB6225 HL00 92/04/01
*****ECONOMLINE PROGRAMS REJECTS THIS CONCERN UNLESS SPEED
CONTROL CAN JUSTIFY MANDATORY CHANGE (DON'T BUILD WITH SPEED
CONTROL UNTIL NEW CONNECTOR IS INCORPORATED). CONCERN IS
RESOLVED IN 94 WITH NEW SWITCH LOCATION. ANY FURTHER
COMMENTS REGARDING OUR REJECTION CAN BE DIRECTED TO BOB
HAZARD, ECONOMLINE PROGRAMS, 08591. DALE BERNHARDT, 73158**

HAZARD, R.W. (313) 39-08591 N K4666 KRB9045 HL00 92/04/15
ELECTRO-WIRE CONCERN AND WILL TAKE NO ACTION ON THIS CONCERN
DEAN SHELL (EMP)*****

ELECTROWIRE (VN 313-336-9393 C 7026 BNPV58 G026 92/04/16
***** CONCURE, AWAITING RESPONSE FROM ORIGINATOR.
***** S. PAPPAS B & C K WIRING *****

* USER IS NO LONGER VALID * N K9183 BP9630 HB00 92/04/16

BODY CONNECTOR SECTION RECOMMENDS REPLACING N88B-14A464-CCA
WITH F3LB-14A464-0A AS A NO COST RUNNING CHANGE FOR 1993.
R L HAYWARD K30094

OLD-HAYWARD, R.L. 313-32-30094 N K5370 KLM6518 HB00 92/04/25
***CONCERN ROUTED TO ORIGINATOR. REJECTED BY ECONOMLINE
PROGRAM MANAGEMENT. **S. SOLOWAY I73664

* USER IS NO LONGER VALID * N K4641 GW7383 HLE1 92/04/27
AN IMPROVED CONNECTOR HAS BEEN RECOMMENDED FOR USE BY BODY
ENGINEERING AS A NO COST CHANGE. CONCERN MUST REMAIN OPEN
UNTIL RESOLUTION IS MADE TO LIGHT TRUCK ENGINEERING'S
SATISFACTION.

PRILEY, J.A. (JOH K46928 N K4513 JAP3648 HL00 92/05/05

SAHUKAR, ANIL K N K4513 ASB1905 HL00 92/05/08
CONCERN RAISED TO "S" STATUS PER J. PRILEY'S ABOVE COMMENTS.
**** MARTHA, PLEASE LET ME KNOW IF I NEED TO DO ANYTHING
FURTHER.

A.J. SAHUKAR I72702

SAHUKAR, ANIL K N K4513 ASB1905 HL00 92/05/08
BASED ON 6/5/92 MEETING WITH J. RITE AND W. CHANDONI, PM
WILL APPROVE AND PROCESS AS A RUNNING CHANGE FOR F-SERIES/
BROWCO/ECONOMLINE. CLOSURE STATEMENT: FAILURE OF THE SWITCH

(CONTINUED)

-MORE-

CONCERN DETAIL

PRINT DATE/TIME: 99/04/13 12:03
PAGE: 7

CONCERN NUMBER 1
C10190755 1

ORIGIN ACTIVITY
ORIGINATOR:

ML00 LIGHT TRUCK PRODUCT
SAHUKAR, ANIL H.

DATE: 92/02/04
PHONE: (313)337-2702

P MGT AUTH:A
STATUS: C

*****FURTHER DESCRIPTION/CONCERN RESOLUTION/REASON FOR REJECTION ETC.*****

DESCRIPTION:

& CONNECTOR SEAL (SHORT CIRCUIT) IN THE FIELD WILL BE VERY DIFFICULT TO DETECT AND COULD RESULT IN MULTIPLE ATTEMPTED REPAIRS.

PELKEY, J.A (JOH X46928 N K4513 JAP3648 ML00 92/06/08
***AUTHORIZED FOR ZERO PC COST/ZERO TOOLING FOR 1993 1/2.
***** M. ROBINSON FOR L. GERMAN *****
* USER IS NO LONGER VALID * N K4661 LGS453 ML00 92/06/08
***AUTHORIZED FOR SCOMOLINE FOR 1993 1/2 BY AT \$0 PC/\$0
TOOLING. S. SOLOMAN K73864
* USER IS NO LONGER VALID * N K4641 GW7383 ML00 92/06/08
*** B. PAPPAS, L. WHEATY; THIS CR HAS BEEN REOPENED/STY
ELECTRICAL DIST 313-39-84362 N K5180 K5180 MB00 92/06/08
***** ELECTRONICS, BOTH ABOVE ENTRY FROM PROGRAM MANAGEMENT
* USER IS NO LONGER VALID * N K5183 BP9630 MB00 92/06/09
THAT THE CONCERN HAS BEEN APPROVED. PLEASE PROCESS ASAP!
***** B. PAPPAS B & C WIRING *****
* USER IS NO LONGER VALID * N K5183 BP9630 MB00 92/06/09
CONCERN ROUTED TO HATT/ANULARE FOR DESIGN ACTION PER
6/12 PINK MEETING. *** G. MAGONYK
* USER IS NO LONGER VALID * N K4641 GW7383 ML00 92/06/12
FUEL SYSTEMS WILL CONTACT HURON PRODUCTS (SUPPLIER OF ORGAN
ISER) TO DETERMINE ANY VARIABLE COSTS ASSOCIATED WITH THE
CHANGE. FOLLOWING HURON PRODUCTS RESULTS, FUEL SYSTEMS
* USER IS NO LONGER VALID * N K4683 LAA6224 ML00 92/06/12
FUEL SYSTEMS WILL FILL A NOTICE AND INITIATE DRO. ORGANISER
P/N'S WILL BE DROPPED TO REPRESENT 1993 LEVEL COMPONENTS AND
LAYOUTS AS WELL AS VVD'S WILL BE UPDATED TO CALL OUT NEW
ELECTRICAL HARNESS PART NUMBERS.
***** LOUIS A. ANULARE EXT 73412 *****
* USER IS NO LONGER VALID * N K4503 LAA6224 ML00 92/06/12
FUEL SYSTEMS CANNOT BEGIN THE ABOVE MENTIONED WORK UNTIL
PART NUMBERS ARE ADDED TO THE DESCRIPTION SCREEN OF THIS CR.
***** LOUIS A. ANULARE EXT. 73412 *****
* USER IS NO LONGER VALID * N K4503 LAA6224 ML00 92/06/12
THE NEW CONNECTOR PART NUMBER IS ON THE DESCRIPTION SCREEN
PER BOB HAYWARD'S ENTRY. BILL PAPPAS - PLEASE SEE THAT BWP
GETS THE NEW HARNESS P/N 'S TO ANULARE SO HE CAN PROCESS.
WE NEED TO MOVE ON THIS. THANKS. PELKEY
PELKEY, J.A (JOH X46928 N K4513 JAP3648 ML00 92/06/16
***** ELECTRONICS, PLEASE NOTE INPUT FROM J. PELKEY AND
RESPOND.
***** B. PAPPAS B & C WIRING *****
* USER IS NO LONGER VALID * N K5183 BP9630 MB00 92/06/16
THIS CHANGE AFFECTS W/A'S LISTED BELOW:

(CONTINUED)

-MORE-

CONCERN DETAIL

PRINT DATE/TIME: 99/04/13 12:03
PAGE: 8

CONCERN NUMBER
C10190786

ORIGIN ACTIVITY
ORIGINATOR:

ML00 LIGHT TRUCK PRODUCT
SAHUKAR, ANIL E.

DATE: 92/02/04
PHONE: (313)337-2702

D MGT AUTH:A
STATUS: C

*****FURTHER DESCRIPTION/CONCERN RESOLUTION/REASON FOR REJECTION ETC.*****

DESCRIPTION:

F30B-14406-BA REPLACES F20B-14406-A LEVEL
F30B-14406-BA REPLACES F20B-14406-F LEVEL
F30B-14406-BA REPLACES F20B-14406-G LEVEL
F30B-14406-BA REPLACES F20B-14406-H LEVEL
F30B-14406-BA REPLACES F20B-14406-J LEVEL
THIS CHANGE ALSO AFFECTS F30B-14406-B, C, & D LEVEL PRINTS
*****BRYAN ULRICH (BUP)*****
*****ROUTE TO BILL PAPPAS (BACH)*****
ELECTRONIC (VW 313-336-9393 C 7026 BHPV58 G026 92/06/19
***** ELECTRONIC, PLEASE RESPOND ON TIMING OF PCI PACKAGE?
***** B. PAPPAS & C. BIRING *****
* USER IS NO LONGER VALID * N K5183 BP9630 NB00 92/06/22
*** ROUTED TO L. GORMAN FOR APPROVAL OF \$1K TOOLING COST
OVERSEEN BY BOB BURG. M. LEBOWITZ
* USER IS NO LONGER VALID * N K4541 GW7383 ML00 92/06/23

L. GORMAN NOT AFFECTED, ROUTED TO D. BRENNHARDT FOR
* USER IS NO LONGER VALID * N K4561 LLA5453 ML07 92/06/23
R. HAZARD.
*****T. WALLACE FOR L. GORMAN*****

* USER IS NO LONGER VALID * N K4561 LLA5453 ML07 92/06/23
FUEL SYSTEM HAS ISSUED A DRO TO UPDATE FUEL SYSTEM ORGANIZER
LAYOUTS. NOTICE WILL NOT BE FILED DUE TO NO CHANGE IN
PIECE COST OF ELECTRICAL HARNESS OR ANY CHANGE TO FIT &
FUNCTION (OVERALL APPEARANCE).
LOUIS A. AMULARE EXT. 73412
* USER IS NO LONGER VALID * N K4583 LAA5224 ML00 92/07/01
FUEL SYSTEMS HAS ISSUED A DRO TO REQUEST 'A' SHEETS FOR THE
NEW FUEL AND BRAKE ORGANIZERS. HOWEVER, AT THIS TIME I
BELIEVE THAT IT MAY BE MORE BENEFICIAL TO ISSUE A BLANKET
ORDER TO REPLACE THE ELECTRICAL HARNESS SINCE THE NEW CONNECT
OR IS COMPATIBLE WITH THE OLD CONNECTOR. IF AN AREA CANNOT
BE ISSUED ADDITIONAL 'A' SHEETS WILL BE REQUIRED FOR ALL REL-
BASED ORGANIZERS (1992, 93, 94). LOUIS A. AMULARE EXT. 73412
* USER IS NO LONGER VALID * N K4503 LAA5224 ML00 92/07/26
LTH BRACE CONSIDER ON AREA CHANGE SINCE FIT & FUNCTION IS NOT
AFFECTED (WOULD EXPEDITE CHANGE). WIRING PRINTS MUST STILL
BE REVISED - BACK DECISION.
DELENY, J.A (JOH K45928 N K4513 JAP3548 ML00 92/07/26
***CONCERN CLOSED PER LT NOTICE BEING DELETED - CHANGE TO
BE DONE ON BREA. S. SOLOMAN
* USER IS NO LONGER VALID * N K4541 GW7383 ML00 92/08/12

-MORE-

CONCERN DETAIL

PRINT DATE/TIME: 99/04/13 12:03
PAGE: 5CONCERN NUMBER
C10190755ORIGIN ACTIVITY: HLG0 LIGHT TRUCK PRODUCT
ORIGINATOR: SAHUKAR, ANIL E.DATE: 92/02/04
PHONE: (313)337-2702P MNT AUTH: A
STATUS: C

*****RESOLUTION OF CONCERN*****

ACTIVITY: H800
AGE DATE: 92/05/08
REMARKS:
MODEL CODES:
NOTICE: H800 & 10190755 000
EFFECTIVE IN: J4P93ARESPONSE CODE: AC
MODULE LEADER NAME: D. BARRETTSCHEDULED DATES- APPROVED: 92/07/10
COMPLETE: 00/00/00
DISTRIBUTED: 00/00/00
INCORPORATED: 00/00/00ACTUAL DATES- APPROVED: 92/07/13
COMPLETE: 92/07/16
DISTRIBUTED: 92/08/07
INCORPORATED: 00/00/00
REJECTED: 00/00/00

LISTING OF CALIBRATION NUMBER:

LISTING OF EFFECTIVE TYPE/POINT:

LISTING OF PROGRAM ID/SEQUENT:

*****MANUFACTURING ACTIVITIES AFFECTED*****

MFG ACT: REQUEST: PHAS: LEAD: VEH COST: TOOLING COST:
ASSEMBLY COST: FAC COST: VEH WGT: UNIT OF MEASURE:

ENGINEERING ACTIVITY'S ESTIMATES:

VEHICLE COST: 0.00 TOOLING COST: 3000 ASSEMBLY LABOR: 0.00 FACILITY COST:
WARRANTY COST: 0.00 VEH WGT: 0.0000 UNIT OF MEASURE: KG R/1000: 0.50
TGM: 0.00 ASSEMBLY MIN: 000000

ENGINEERING ACTIVITY'S TARGETS:

VEHICLE COST: 0.00 TOOLING COST: 3000 ASSEMBLY LABOR: 0.00 FACILITY COST: 0
WARRANTY COST: 0.00 VEH WGT: 0.0000 UNIT OF MEASURE: KG R/1000: 0.00
TGM: 0.00

ENGINEERING ACTIVITY'S STATUS OF NOTICES (CALCULATED FROM NOTICES):

VEHICLE COST: 0.00 TOOLING COST: 3000 ASSEMBLY LABOR: 0.00 FACILITY COST: 0
WARRANTY COST: 0.00 VEH WGT: 0.0000 UNIT OF MEASURE: LBACTIVITY: HLT4
AGE DATE: 92/05/08
REMARKS:
MODEL CODES:
NOTICE:RESPONSE CODE: NA
MODULE LEADER NAME: RUK (CARBOLT)

SCHEDULED DATES- APPROVED:

ACTUAL DATES- APPROVED:

-MORE-

CONCERN DETAIL

PRINT DATE/TIME: 99/04/13 12:03
PAGE: 10

CONCERN NUMBER
C10190795

ORIGIN ACTIVITY: M100 LIGHT TRUCK PRODUCT
ORIGINATOR: SAHUKAR, ANIL S.

DATE: 92/02/84
PHONE: (313)337-2702

F MGT AUTH:A
STATUS: C

-----RESOLUTION OF CONCERN-----

ACTIVITY: M174
EFFECTIVE IN:

COMPLETE:
DISTRIBUTED:
INCORPORATED:

RESPONSE CODE: NA

COMPLETE:
DISTRIBUTED:
INCORPORATED:
REJECTED:

LISTING OF CALIBRATION NUMBER:

LISTING OF EFFECTIVE TIME/POINT:

LISTING OF PROGRAM ID/SEGMENT:

*****MANUFACTURING ACTIVITIES AFFECTED*****
MFG ACTY: REQUEST: FEAS: LEAD:
ASSEMBLY COST: FAC COST:

VEH COST:
VEH WGT:

TOOLING COST:
UNIT OF MEASURE:

ENGINEERING ACTIVITY'S ESTIMATES:

VEHICLE COST: TOOLING COST:
WARRANTY COST: VEH WGT:
TON: ASSEMBLY MIN: 000000{

ASSEMBLY LABOR:
UNIT OF MEASURE:

FACILITY COST:
R/1000:

ENGINEERING ACTIVITY'S TARGETS:

VEHICLE COST:	0.00	TOOLING COST:	0	ASSEMBLY LABOR:	0.00	FACILITY COST:	0
WARRANTY COST:	0.00	VEH WGT:	0.0000	UNIT OF MEASURE:	OZ	R/1000:	0.00
TON:	0.00						

ENGINEERING ACTIVITY'S STATUS OF NOTICES (CALCULATED FROM NOTICES):

VEHICLE COST:	TOOLING COST:	ASSEMBLY LABOR:	FACILITY COST:
WARRANTY COST:	VEH WGT:	UNIT OF MEASURE:	

ACTIVITY: M100
AGE DATE: 92/06/12
REMARK: ACTION TO BE TAKEN ON AREA BY BOOT ELECTRICAL
MODULE LEADER NAME: ASHOKAN/ANILARE (CD)

MODEL CODE:
NOTICE:
EFFECTIVE IN:

SCHEDULED DATE- APPROVED:
COMPLETE:
DISTRIBUTED:
INCORPORATED:

ACTUAL DATE- APPROVED:
COMPLETE:
DISTRIBUTED:
INCORPORATED:
REJECTED:

-MORE-

CONCERN DETAIL

PRINT DATE/TIME: 99/04/13 12:03
PAGE: 11

CONCERN NUMBER
C10180785

ORIGIN ACTIVITY: HL00 LIGHT TRUCK PRODUCT
ORIGINATOR: SARUKAN, ANIL E.

DATE: 92/02/04
PHONE: (313)337-2702

P WGT AUTH: A
STATUS: C

*****RESOLUTION OF CONCERN*****

ACTIVITY: HL00 RESPONSE CODE: TR
LISTING OF CALIBRATION NUMBER:
LISTING OF EFFECTIVE TYPE/POINT:
LISTING OF PROGRAM ID/SEGMENT:

*****MANUFACTURING ACTIVITIES AFFECTED*****
MFG ACTY: REQUEST: FEAS: LEAD:
ASSEMBLY COST: SAC COST:

VEH COST: TOOLING COST:
VEH WGT: UNIT OF MEASURE:

ENGINEERING ACTIVITY'S ESTIMATES:

VEHICLE COST:	0.00	TOOLING COST:	0	ASSEMBLY LABOR:		FACILITY COST:	0
WARRANTY COST:		VEH WGT:	0.0000	UNIT OF MEASURE:	LB	R/1000:	0.00
TOW:	0.00	ASSEMBLY MIN:	000000				

ENGINEERING ACTIVITY'S TARGETS:

VEHICLE COST:	0.00	TOOLING COST:	0	ASSEMBLY LABOR:	0.00	FACILITY COST:	0
WARRANTY COST:	0.00	VEH WGT:	0.0000	UNIT OF MEASURE:	LB	R/1000:	0.00
TOW:	0.00						

ENGINEERING ACTIVITY'S STATUS OF NOTICES (CALCULATED FROM NOTICES):

VEHICLE COST:	0.00	TOOLING COST:	0	ASSEMBLY LABOR:	0.00	FACILITY COST:	0
WARRANTY COST:	0.00	VEH WGT:	0.0000	UNIT OF MEASURE:	LB		

ACTIVITY: HL01
AGE DATE: 92/03/08
REMARKS: 30C090 7/2 - DRO TURNED IN 8/6
MODEL CODE:
NOTICE:
EFFECTIVE IN:

RESPONSE CODE: NA
MODULE LEADER NAME: ***CLOSED***

SCHEDULED DATES- APPROVED:
COMPLETE:
DISTRIBUTED:
INCORPORATED:

ACTUAL DATES- APPROVED:
COMPLETE:
DISTRIBUTED:
INCORPORATED:
REJECTED:

LISTING OF CALIBRATION NUMBER:
LISTING OF EFFECTIVE TYPE/POINT:

-MORE-

CONCERN DETAIL

PRINT DATE/TIME: 99/04/13 12:03
PAGE: 12

CONCERN NUMBER
C10180755

ORIGIN ACTIVITY: NL00 LIGHT TRUCK PRODUCT
ORIGINATOR: SABUKAR, AMIL E.

DATE: 92/02/04
PHONE: (313)337-2702

P MGT AUTH: A
STATUS: C

*****RESOLUTION OF CONCERN*****

ACTIVITY: NL01

RESPONSE CODE: MA

LISTING OF PROGRAM ID/SEGMENT:

*****MANUFACTURING ACTIVITIES AFFECTED*****

MFG ACTY: REQUEST: FEAS: LEAD:
ASSEMBLY COST: FAC COST:

VEH COST:
VEH WGT:

TOOLING COST:
UNIT OF MEASURE:

ENGINEERING ACTIVITY'S ESTIMATES:

VEHICLE COST: TOOLING COST: ASSEMBLY LABOR: FACILITY COST:
WARRANTY COST: VEH WGT: UNIT OF MEASURE: R/1000:
TOW: ASSEMBLY MIN: 000000{

ENGINEERING ACTIVITY'S TARGETS:

VEHICLE COST: 0.00 TOOLING COST: 0.0000 ASSEMBLY LABOR: 0.00 FACILITY COST: 0.00
WARRANTY COST: 0.00 VEH WGT: 0.0000 UNIT OF MEASURE: OS R/1000: 0.00
TOW: 0.00

ENGINEERING ACTIVITY'S STATUS OF NOTICES (CALCULATED FROM NOTICES):

VEHICLE COST: TOOLING COST: ASSEMBLY LABOR: FACILITY COST:
WARRANTY COST: VEH WGT: UNIT OF MEASURE:

ACTIVITY: NL71
AGE DATE: 92/06/12

RESPONSE CODE: TR
MODULE LEADER NAME: JMI (ASSIGNED)

REMARKS:
MODEL CODE:
NOTICE:
EFFECTIVE IN:

SCHEDULED DATE- APPROVED:
COMPLETE:
DISTRIBUTED:
INCORPORATED:

ACTUAL DATE- APPROVED:
COMPLETE:
DISTRIBUTED:
INCORPORATED:
REJECTED:

LISTING OF CALIBRATION NUMBER:

LISTING OF EFFECTIVE TYPE/POINT:

LISTING OF PROGRAM ID/SEGMENT:

*****MANUFACTURING ACTIVITIES AFFECTED*****

-NONE-

CONCERN DETAIL

PRINT DATE/TIME: 99/04/13 12:03

PAGE: 13

CONCERN NUMBER
C10190755ORIGIN ACTIVITY: M100 LIGHT TRUCK PRODUCT
ORIGINATOR: SARUKAR, ANIL S.DATE: 92/02/04
PHONE: (313) 337-2702P MGT AUTH: A
STATUS: C

*****RESOLUTION OF CONCERN*****

ACTIVITY: M171 REQUEST: FRAS: LEAD: RESPONSE CODE: YR
 NPG ACTY: REQUEST: FAC COST: VEH COST: TOOLING COST:
 ASSEMBLY COST: VEH WGT: UNIT OF MEASURE:

ENGINEERING ACTIVITY'S ESTIMATES:

VEHICLE COST: TOOLING COST: ASSEMBLY LABOR: FACILITY COST:
 WARRANTY COST: VEH WGT: UNIT OF MEASURE: R/1000:
 TOW: ASSEMBLY MIN: 000000

ENGINEERING ACTIVITY'S TARGETS:

VEHICLE COST: 0.00 TOOLING COST: 0 ASSEMBLY LABOR: 0.00 FACILITY COST: 0
 WARRANTY COST: 0.00 VEH WGT: 0.0000 UNIT OF MEASURE: OZ R/1000: 0.00
 TOW: 0.00

ENGINEERING ACTIVITY'S STATUS OF NOTICES (CALCULATED FROM NOTICES):

VEHICLE COST: TOOLING COST: ASSEMBLY LABOR: FACILITY COST:
 WARRANTY COST: VEH WGT: UNIT OF MEASURE:

*****PROPOSED RESOLUTION*****

ACTIVITY	DATE	RESOLUTION
M100	92/04/14	REPLACE 888B-14A464-CCA WITH F3LB-14A464-DA
M100	92/07/82	DRAFTING WILL UPDATE LAYOUT AND DETAIL WITH NEW PART NUMBERS. SUPPLIER WILL BE NOTIFIED OF THE CHANGE.

*****TOTAL INCREMENTAL VEHICLE COST/WEIGHT/QUALITY*****

TOTAL ENGINEERING ACTIVITY ESTIMATES:

VEHICLE COST: 0.00 TOOLING COST: 3000 ASSEMBLY LABOR: 0.00 FACILITY COST: 0
 WARRANTY COST: 0.00 VEH WGT: 0.0000 UNIT OF MEASURE:

TOTAL CONCERN TARGETS:

VEHICLE COST: 0.00 TOOLING COST: 3000 ASSEMBLY LABOR: 0.00 FACILITY COST: 0
 WARRANTY COST: 0.00 VEH WGT: 0.0000 UNIT OF MEASURE:

TOTAL STATUS OF NOTICES (CALCULATED FROM NOTICES):

VEHICLE COST: 0.00 TOOLING COST: 3000 ASSEMBLY LABOR: 0.00 FACILITY COST:
 WARRANTY COST: 0.00 VEH WGT: 0.0000 UNIT OF MEASURE:

-NONE-

CONCERN DETAIL

PRINT DATE/TIME: 99/04/13 12:03

PAGE: 14

CONCERN NUMBER
C10190753ORIGIN ACTIVITY NLOO LIGHT TRUCK PRODUCT
ORIGINATOR: SAHUKAR, ANIL E.DATE: 92/02/04
PHONE: (313)337-2702P MGT AUTH: A
STATUS: C

APPROVALS

REGION	DEPARTMENT	USERID	ACTIVITY	APPROVER'S NAME	DATE APPROVED	APPROVAL	STATUS
N	K4513	ANS1905	NLOO	SAHUKAR, ANIL E.	92/02/04		W
N	K4513	JAP3648	NLOO	PELKEY, J.A. (JOHN)	92/02/05	Y	
N	K4513	MMH4640	NLOO	MODI, NIKU K.	92/02/11	Y	
N	K4510	JPR1495	NLOO	RITE, J.P. (JIM)	92/02/18	R	
N	K4513	ANS1905	NLOO	SAHUKAR, ANIL E.	92/02/22		A
N	K4641	TET9934	NLOO	TAJAK, T.M. (TERRY)	92/02/28	R	
N	K5183	LEND118	NB00	WENSKAY, LARRY K.	92/04/21	R	
N	K5183	BP9630	NB00	PAPFAS, BILL	92/03/02	R	
C	7026	EMPVMS8	G026	ELECTRONICS (VMS8 CM	92/03/02	R	
N	K5183	BP9630	NB00	PAPFAS, BILL	92/03/10	R	
N	K4641	GM7383	NLE1	F/S VEH CST, WOT & C	92/03/04	R	
N	K4513	ANS1905	NLOO	SAHUKAR, ANIL E.	92/03/12	R	
N	K5370	RLH4538	NB00	RAYWARD, R.L. (SECT. S	92/04/21	Y	
N	K5370	LANG7526	NB00	GILPIN, L.W.	92/03/21	U	
C	7026	EMPVMS8	G026	ELECTRONICS (VMS8 CM	92/03/10	R	
N	K5370	RFT7473	NB00	FRONTS, R.F.	92/03/24	Y	
C	7026	EMPVMS8	G026	ELECTRONICS (VMS8 CM	92/03/10	R	
N	K5183	BP9630	NB00	PAPFAS, BILL	92/03/11	R	
N	K5180	K5180	NB00	CAR/TRUCK ELECT. DIS	92/03/13	R	
N	K5370	RLH4538	NB00	RAYWARD, R.L. (SECT. S	92/03/14	R	
N	K5183	BP9630	NB00	PAPFAS, BILL	92/03/13	Y	
N	K4534	GCRH15	NLOO	HANDALL, GEORGE C. (G	92/03/13	Y	
C	7026	EMPVMS8	G026	ELECTRONICS (VMS8 CM	92/03/13	R	
N	K5183	BP9630	NB00	PAPFAS, BILL	92/03/16	Y	
N	K5920	NDJ3249	NB00	JONES, MIKE D.	92/03/19	R	
N	K5370	DSY1705	NB00	YENNAK, D.S.	92/03/17	U	
C	7026	EMPVMS8	G026	ELECTRONICS (VMS8 CM	92/03/16	R	
N	K4641	SB6225	NLOO	SOLOWAY, S. (SHERRI)	92/04/01	R	
N	K5183	BP9630	NB00	PAPFAS, BILL	92/03/27	R	
N	K5180	K5180	NB00	CAR/TRUCK ELECT. DIS	92/03/27	R	
C	7026	EMPVMS8	G026	ELECTRONICS (VMS8 CM	00/00/00		
N	K4666	EMH9045	NLOO	RAYWARD, R.W. (RON)	92/04/15	R	
N	K4641	GM7383	NLE1	F/S VEH CST, WOT & C	92/04/24	R	
N	K5183	LEND118	NB00	WENSKAY, LARRY K.	92/04/21	R	
N	K5183	BP9630	NB00	PAPFAS, BILL	92/04/16	R	
C	7026	EMPVMS8	G026	ELECTRONICS (VMS8 CM	00/00/00		
N	K4513	ANS1905	NLOO	SAHUKAR, ANIL E.	92/04/27	R	
N	K5370	TSD468	NB00	SHENCKEL, T. (TIM)	92/04/27	Y	
N	K5370	RLH4538	NB00	RAYWARD, R.L. (SECT. S	92/04/28	R	
N	K4641	GM7383	NLE1	WASOWYK, GERRY	92/04/27		X
N	K4513	JAP3648	NLOO	PELKEY	92/05/05	Y	
N	K4641	GM7383	NLE1	WASOWYK	92/05/06	R	
N	K4666	EMH9045	NLOO	RAYWARD, R.W. (RON)	00/00/00		

-PAGE-

CONCERN DETAIL

PRINT DATE/TIME: 99/04/13 12:03

PAGE: 15

CONCERN NUMBER

C10190755

ORIGIN ACTIVITY
ORIGINATOR:NL00 LIGHT TRUCK PRODUCT
BAROKAR, ANIL K.DATE:
PHONE:92/02/04
(313)337-2702P NOT AUTH:A
STATUS: C

APPROVALS

REGION	DEPARTMENT	USERID	ACTIVITY	APPROVER'S NAME	DATE APPROVED	APPROVAL	STATUS
N	K4513	AKH1905	NL00	BAROKAR, ANIL K.	92/05/08		N
N	K4661	LLG5453	NLF7	COONAN, L. LEE	92/06/08		
N	K5183	BP9630	NR00	PAPPAS, BILL	92/06/09	R	
N	K5183	IKW0118	NR00	NEWSEY, LARRY K.	92/06/09	R	
C	7026	BNPWN58	Q026	ELECTRONICS (VMS) CM	00/00/00		
N	K4503	LAA6224	NL00	ANULARE, LOUIS A. (7	92/06/12	Y	
C	7026	BNPWN58	Q026	ELECTRONICS (VMS) CM	00/00/00		
N	K4500	PJA8798	NL00	ROSBORN, PAUL J.	92/06/15	R	
N	K4503	LAA6224	NL00	ANULARE, LOUIS A. (7	92/06/12	Y	
N	K4503	JWH3259	NL00	HATT, J. M. (718)	92/07/02	Y	
N	K4503	LAA6224	NL00	ANULARE, LOUIS A. (7	92/07/02	Y	
N	K5183	BP9630	NR00	PAPPAS	92/06/16	R	
C	7026	BNPWN58	Q026	ELECTRONICS (VMS) CM	00/00/00		
C	7026	BNPWN58	NR00	ELECTRONICS (VMS) CM	92/06/19		C
N	K5183	BP9630	NR00	PAPPAS, BILL	92/06/22	R	
N	K4503	LAA6224	NL00	ANULARE, LOUIS A. (7	92/07/02	Y	
C	7026	BNPWN58	Q026	ELECTRONICS (VMS) CM	00/00/00		
N	K4661	LLG5453	NLF7	COONAN, L. LEE	92/06/23	U	
N	K4666	HNH9045	NL00	HARRARD, R.H. (ROW)	00/00/00		
N	K4503	LAA6224	NL00	ANULARE, LOUIS A. (7	92/07/28	Y	
N	K4503	JWH3259	NL00	HATT, J. M. (718)	92/07/28	Y	
N	K5183	BP9630	NR00	PAPPAS, BILL	92/07/28	R	
N	K4536	TAR2803	NL00	RODGERS, T.A.	00/00/00		
N	K4666	HNH9045	NL00	HARRARD, R.H. (ROW)	00/00/00		
N	K4513	JAP3648	NL00	HELENY, J.A. (JOHN)	92/07/28	R	
N	K4678	KANS919	NL00	BRICKSON, K.A. (KEI)	92/08/23	U	

3713 2028

K

3713 2027



DuPont Circleville

Brian Digg
34 Forest Street
Attleboro, MA, 02703
Fax 508-336-3586

February 23, 1999

Dear Brian

I have checked our records and have not found any test data on Kapton® FN type film and break fluid exposure in our files.

I have also spoken to several colleagues and we are unaware of any issues with the Kapton® FN that has been used in automotive diaphragms.

Sorry we can not be of more help. If you have any questions please call.

Regards,

Mark McAless
Sr. Tech Service Rep. Kapton®
740-474-0725

See MATERIAL
for KAPTON
11-13

Post-Net Fax Note	7871	Date	2/23/99
To	HEIZ	From	
Cn/Dept.	1000000000	Co.	
Phone #		Phone #	
Fax #	313-390-4145		

Form 2-7/97

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3713 2028



3713 2029

RELIABLE CARRIERS, INC.

ICC No. MC-172894

P.E. No.

41555 Koppertick Rd., Canton, MI 48107 (313) 453-8877
220 S. 54th St., Chandler, AZ 85226 (602) 496-8080
453 Thorpe Rd., Orlando, FL 32824 (407) 850-8876

FREIGHT BILL

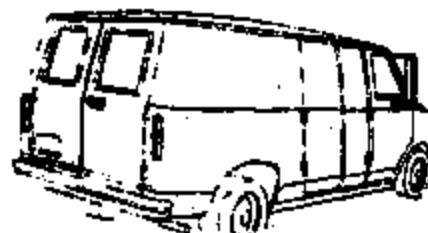
CONDITION REPORT AND DELIVERY RECEIPT

SHIP NO.

OR Romeo moving GR		CONTAINER TO Ford motor	
ADDRESS		ADDRESS	
CITY Romeo STATE MI		CITY Dearborn STATE MI	
PHONE		PHONE	
LOAD DATE		DELIVERY DATE	
LOAD TIME		DELIVERY TIME	
YEAR MAKE DESCRIPTION	VEHICLE NO.	COLOR	SPRINKLER (YES/NO)
AUTO Town Car	NY 669063		
REMARKS			

DESCRIBE ANY EXCEPTIONS - DENTS - SCRATCHES - CRACKED WINDOWS - RUBS - RUST, ETC BEFORE LOADING

Salt covered condition noted



3713 2030

DATE TO	DRIVER	<i>[Signature]</i>	DATE	3-26-99
	HAULER	<i>[Signature]</i>	DATE	3-26-99
	WAGON	<i>[Signature]</i>	DATE	3-26-99
	TRAILER	<i>[Signature]</i>	DATE	3-26-99

NY 66906

CONSIGNEE COPY

SEE REVERSE FOR TRANSPORTATION TERMS AND CONDITIONS

CARRIER'S LIABILITY

RECEIVED, the property described herein and/or on the associated inventory and condition report, in apparent good order, except as noted (contents and mechanical condition unknown) consigned as indicated below, which carrier agrees to carry to its usual place of delivery at destination. It is mutually agreed that every service to be performed by the carrier shall be subject to the contract terms on the reverse side of this bill of lading. The shipper is familiar with and agrees to those contract terms.

Cargo liability amounts are limited by CONTRACT TERMS of this bill of lading to a maximum of \$1,000,000 per loaded carrier conveyance.

Contract Terms

1. The carrier shall be liable for physical loss of or damage to any ~~articles~~ ^{articles} from external cause while being carried or held in storage in transit EXCEPT documents, currency, money, jewelry, watches, precious stones, articles of extraordinary value or personal articles in the vehicle, and EXCEPT loss or damage caused by or resulting:
 - a. From acts of God.
 - b. From the public enemy, the authority of law, hostile or warlike actions in time of peace or war, strikes, lockouts, labor disturbances, riots, etc.
 - c. From an act or omission or order of shipper.
 - d. From damages caused by defect or inherent vice of the article, or for damages caused by leaking battery acids, brake fluids, cooling system, anti-freeze or lubricants.
2. If an article is lost or damaged, the shipper's "actual loss" shall be determined by the article's repair or replacement cost, whichever is less. Where an article cannot be suitably repaired or replaced, the proper measure of damages shall be the article's original cost, adjusted downward to reflect depreciation over average useful life. Carrier's transportation rates are based on "released liability." Additional insurance is available in excess of liability limits stated on front of bill of lading on as needed and quoted basis.
3. The carrier shall not be liable for delay caused by highway obstruction or faulty or impassable highways, or lack of capacity of any highway, bridge or ferry, or caused by breakdown or mechanical defect of vehicles or equipment or any cause other than negligence of the carrier; nor shall the carrier be bound to transport by any particular schedule, means, vehicle, or otherwise than with reasonable dispatch.
4. As a condition precedent to recovery, a claim for any loss, damage, injury or delay must be filed in writing with the carrier within nine (9) months after delivery to the consignee shown on the Bill of Lading or, in the case of failure to make delivery, within nine (9) months after reasonable time for delivery has elapsed; and suit must be instituted against the carrier within two (2) years and one (1) day from the date when written notice is given by the carrier to the claimant that the carrier has disallowed the claim or any part thereof specified in the notice. Where a claim is not filed or a suit not instituted in accordance with the foregoing provisions, the carrier shall not be liable and the claim will not be paid.
5. The shipper shall be liable to the carrier for all applicable charges under this Bill of Lading. The carrier will not deliver or relinquish possession of any property transported by it until all applicable charges have been paid in cash, money order or bank check, except where other satisfactory arrangements have been made in accordance with ICC regulations. Where such arrangements for credit have been made, the carrier will extend the shipper free credit for seven (7) days, excluding Saturdays, Sundays and legal holidays, from the first 12:00 midnight following the carrier's presentation of the bill. If the carrier's bill is not paid within the free credit period, the carrier shall automatically extend credit to the shipper to a total of sixty (60) days, including the seven-day free credit period, and the shipper shall pay a service charge of one percent (1%) of the bill, but not less than \$10.00.
6. The carrier shall not grant credit to any shipper that fails to pay a duly presented bill within the extended 30-day credit period, unless such shipper affirmatively satisfies the carrier that all future bills will be paid strictly in accordance with ICC regulations for the settlement of carrier rates and charges.
7. The carrier may require prepayment of charges for a specific service in full or in part any time after commencing performance of such services as requested by the shipper.

3713 2031

Vehicle Information Report

GENERAL VEHICLE
INFORMATION:

(Related Claims)

VIN:	1LNLM1W1N1	Yak Lim	C/VN - TOWN CAR (TNG/TN116) [91-97]	Eng Serial No:	W
Model Year:	1992	Market Division:	C/M - L-M DIVISION DERIVATIVE	Body Style:	"
Veh Type:	C	Drive Code:	C/S - 2 WHL L/R REAR DRIVE	Engine:	C/VN - N-M 4.9L SCHE EFI NA
Inv. Dealer:	11644	Body Cab Style:	C/F - 4 DOOR SEDAN-6 LITE	Transmission:	C/DK - 4 SPD AUTO TRANS NA
		Version/Serial:	C/AB - BASE VERSION		

BUILD INFORMATION:

Region: NA - #00000000 Plant: BA - WIDOM PLANT BUILD
Country: USA - #00000000 Prod Date: 20-DEC-1991

SALE INFORMATION:

Region:	NA - North America	Selling Dealer:	325722 - *
Country:	USA - #0000000000	Selling Div StProv:	FL
		Buyer StProv:	OK
Arrival Date:	20-JAN-1992	Red Carpet Lease:	*
Sale Date:	01-FEB-1992	Fleet/Batch/Cs. Lease:	F
Warranty Start Date:	01-FEB-1992	Modified Vehicle:	*
Orig Warranty Rate:	01-FEB-1992	Reassembled Vehicle:	* Vehicle Export Flag: N

VOC/EOC:

-----1-----2-----3-----4-----5-----6-----7-----8-----
 M81MY669063 43 5102A0537 CM F PJY JPK 20646 CV P K25A722 3VAYO HT. E W1
 NL3 0 8 KB A751A7 WP H8001

1 of 3

3713.2032

2/26/99 2:16 PM

INSTALLED OPTION INFORMATION:

Air Conditioning:	C/C - A/C AIR CONDITIONER	GVW Code:	-
Alternator Amp Rating:	* - [N/A]	GVW Class Code:	L
Audio Disc:	* - [N/A]	Instrumentation:	* - [N/A]
Axis Ratio:	EQACC - 3.08 FINAL DRIVE RATIO	Mirror(Driver Side):	* - [N/A]
Axis Type:	EKLAC - LIMITED SLIP REAR AXLE	Mirror(Passg Side):	* - [N/A]
Battery Amp Rating:	72	Paint:	PNYAF - MED TITANIUM CC
Brake Code:	FEAAB - 4 WHL ANTI-LOCK BRAKES	Power Antenna:	* - [N/A]
Brake Code(Service):	* - [N/A]	Radios:	AQ - ELETR PREMIUM AM/FM STEREO
Calibration Code:	31UDR05A	Sound System:	* - [N/A]
Color(Automt):	* - [N/A]	Susp Tandem Axle:	* - [N/A]
Color(Triple):	000A4 -	Tire Brand:	AJ - MICHELIN TIRE VENDOR
Delivery Type:	H	Tire Size:	D3QEF - P215/70R15 WSW
Drivetrain Code:	*	Traction Control:	* - [N/A]
Front Seat:	* - [N/A]	Wheel Base:	* - [N/A]
Fuel Type:	* - [N/A]		

ESP INFORMATION: EMISSIONS INFORMATION:

ESP Code:	* Emission Code:	C/B - C/B
ESP Coverage(Miles):	* Emission Cert Type:	F
ESP Coverage(Time):	* Emission Decal Suffix:	HPH
ESP Plan Year:	* Engine Family:	NPM46V3PDR0
ESP Signature Date:		

Any comments? You can contact

webmaster@aws-ford.com

Standard Claims List For Model Year 1992

1LNLM81W3NY	CVB	CM	CPC	CAB	CB	BA	CDK	CVN	20-DEC-1991	01-FEB-1992	325722	USA	19	7M11
AWS Claim Key:	12119874	Trx Code:	884	Labor Hrs:	7	Labor Cost:	21	Material Cost:	19.93	Total C				
Dir Cd-Sub Cd:	02532-*	Name:	KENT GLOVER				Phi	254-8835581	86 TX	City Cd:	USA	Reg Cd		
Dir Cd-Sub Cd:	02532-*	Name:	FORD-MERCURY				Phi	254-8835581	86 TX	City Cd:	USA	Reg Cd		
Cost Comments:	INSUFFICIENT COOLING AIR COND.													
Tech Comments:	TEST & RECHARGE SYSTEM													
NA														

1LNLM81W3NY	CVB	CM	CPC	CAB	CB	BA	CDK	CVN	20-DEC-1991	01-FEB-1992	325722	USA	19	7T02
AWS Claim Key:	12119877	Trx Code:	870	Labor Hrs:	4	Labor Cost:	21.6	Material Cost:	8	Total C				
Dir Cd-Sub Cd:	10906-*	Name:	CREST LINC-MERC SALES				Phi	810-9396000	86 MI	City Cd:	USA	Reg Cd		
Dir Cd-Sub Cd:	10906-*	Name:	INC				Phi	810-9396000	86 MI	City Cd:	USA	Reg Cd		
H+ Sender														

1LNLM81W3NY	CVB	CM	CPC	CAB	CB	BA	CDK	CVN	20-DEC-1991	01-FEB-1992	325722	USA	19	6P06
AWS Claim Key:	12119878	Trx Code:	884	Labor Hrs:	5	Labor Cost:	27	Material Cost:	0	Total C				
Dir Cd-Sub Cd:	10906-*	Name:	CREST LINC-MERC SALES				Phi	810-9396000	86 MI	City Cd:	USA	Reg Cd		
Dir Cd-Sub Cd:	10906-*	Name:	INC				Phi	810-9396000	86 MI	City Cd:	USA	Reg Cd		
Cost Comments:	REPT FASHION BAR BROKE LOOSE FROM CLIP													
NA														

1LNLM81W3NY	CVB	CM	CPC	CAB	CB	BA	CDK	CVN	20-DEC-1991	01-FEB-1992	325722	USA	19	7T03
AWS Claim Key:	12119878	Trx Code:	870	Labor Hrs:	7	Labor Cost:	37.8	Material Cost:	0	Total C				
Dir Cd-Sub Cd:	10906-*	Name:	CREST LINC-MERC SALES				Phi	810-9396000	86 MI	City Cd:	USA	Reg Cd		
Dir Cd-Sub Cd:	10906-*	Name:	INC				Phi	810-9396000	86 MI	City Cd:	USA	Reg Cd		
ATS in detail														

1LNLM81W3NY	CVB	CM	CPC	CAB	CB	BA	CDK	CVN	20-DEC-1991	01-FEB-1992	325722	USA	19	7H03
AWS Claim Key:	12119881	Trx Code:	870	Labor Hrs:	2.4	Labor Cost:	129.6	Material Cost:	182.69	Total C				
Dir Cd-Sub Cd:	10906-*	Name:	CREST LINC-MERC SALES				Phi	810-9396000	86 MI	City Cd:	USA	Reg Cd		
Dir Cd-Sub Cd:	10906-*	Name:	INC				Phi	810-9396000	86 MI	City Cd:	USA	Reg Cd		
NA														

1LNLM81W3NY	CVB	CM	CPC	CAB	CB	BA	CDK	CVN	20-DEC-1991	01-FEB-1992	325722	USA	20	6F18
AWS Claim Key:	12119879	Trx Code:	P05	Labor Hrs:	3	Labor Cost:	43.2	Material Cost:	0	Total C				
Dir Cd-Sub Cd:	10906-*	Name:	CREST LINC-MERC SALES				Phi	810-9396000	86 MI	City Cd:	USA	Reg Cd		
Dir Cd-Sub Cd:	10906-*	Name:	INC				Phi	810-9396000	86 MI	City Cd:	USA	Reg Cd		
NA														

1LNLM81W3NY	CVB	CM	CPC	CAB	CB	BA	CDK	CVN	20-DEC-1991	01-FEB-1992	325722	USA	20	5V01
AWS Claim Key:	12119880	Trx Code:	884	Labor Hrs:	2.5	Labor Cost:	135	Material Cost:	425.53	Total C				
Dir Cd-Sub Cd:	10906-*	Name:	CREST LINC-MERC SALES				Phi	810-9396000	86 MI	City Cd:	USA	Reg Cd		
Dir Cd-Sub Cd:	10906-*	Name:	INC				Phi	810-9396000	86 MI	City Cd:	USA	Reg Cd		
ELECTRIC see detail														

Any comments? You can contact

Claim Detail Report



Model Year = 1992; Claim Key = 12119878

Vehicle Information

Model Year: 1992
Market Derived: C/M - L-M DIVISION DERIVATIVE
Body/Cab Type: C/FC - 4 DOOR SEDAN-6 LITE
Version/Series: C/AB-BASE VERSION
Drive Type: C/B-2 WHL L/H REAR DRIVE
Vehicle Line: C/VB-TOWN CAR (FN36/FN116)
[91-97]
Warranty Start Date: 01-FEB-1992
Production Date: 20-DEC-1991
VIN: 1LNLM81W3N [REDACTED]

Claim Information

Document Number: 062241
Repair Date: 26-JUL-1993
Distance: 22362
TIS: 19

Dealer Information:

Dealer Name: CREST LINC-MERC SALES INC
Dealer Code: 10906 - *
Address: 36200 VAN DYKE AVE
City: STERLING HEIGHTS
State: MI Zip Code: 48312
Country: USA Region Code: NA
Phone: (810)600-6000

Expense Information

Customer Paid Amount: 0
Deductible Amount: 0
Dealer Paid Amount: 0
Labor Cost: 37.8
Misc. Expense Amount: 0
Part Markup Amount:
Material Cost: 0
Total Cost Gross: 37.8

Cust. Concern Code: H02 - BRAKES GRAB OR LOCK-UP
Condition Code: 42 - DOES NOT OPERATE PROPERLY
Technician Comment:
Customer Comment:

Labor Op Code	Labor Op Description	Labor Op Cost
2219D	ANTI-LOCK BRAKE SYSTEM DIAGNOSIS	0

Causal	Full Part Number	Part	Part	Extended			
Flag	PREF	BASE	SUFF	Description	CFSC	Quality	Amount
Y	*	2C219	*	MODULE-BRK ANTI/LK	060903	0	0

Any comments? You can contact



webmaster@aws-ford.com

Claim Detail Report



Model Year = 1992; Claim Key = 12119880

Vehicle Information

Model Year: 1992
Market Derived: C/M - L-M DIVISION DERIVATIVE
Body/Cab Type: C/FC - 4 DOOR SEDAN-6 LITE
Version/Series: C/AB-BASE VERSION
Drive Type: C/B-2 WHL L/H REAR DRIVE
Vehicle Line: C/VB-TOWN CAR (FN36/FN116)
[91-97]
Warranty Start Date: 01-FEB-1992
Production Date: 20-DEC-1991
VIN: 1LNLM81W3N1 [REDACTED]

Claim Information

Document Number: 063777
Repair Date: 21-SEP-1993
Distance: 24923
TIS: 20

Dealer Information:

Dealer Name: CREST LINC-MERC SALES INC
Dealer Code: 10906 - *
Address: 36200 VAN DYKE AVE
City: STERLING HEIGHTS
State: MI Zip Code: 48312
Country: USA Region Code: NA
Phone: (810)600-6000

Expense Information

Customer Paid Amount: 0
Deductible Amount: 0
Dealer Paid Amount: 0
Labor Cost: 135
Misc. Expense Amount: 0
Part Markup Amount:
Material Cost: 425.53
Total Cost Gross: 560.53

Cust. Concern Code: N27 - VIBRATION OR SHUDDER WHILE BRAKING

Condition Code: 42 - DOES NOT OPERATE PROPERLY

Technician Comment:

Customer Comment:

Labor Op Code	Labor Op Description	Labor Op Cost
2001AT	BRAKE SHOES / PAD ASSEMBLIES - HYDRAULIC REMOVE AND INSTALL OR REPLACE	0
2001AST	DISC BRAKE ROTOR AND HUB REPLACE	0
2026BT	DISC BRAKE ROTOR - REAR REPLACE	0

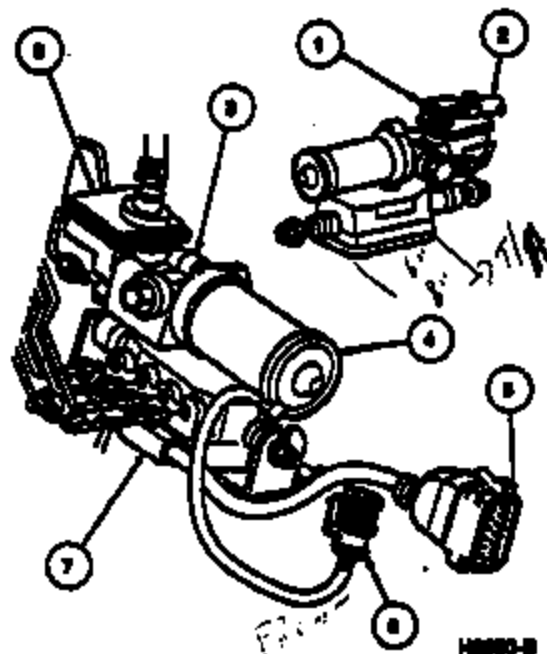
Causal	Full Part Number			Part		Part	Extended
Flag	PREF	BASE	SUFF	Description	CPSC	Quality	Amount
Y	F3VY	1125	A	DISC - FRONT WHEEL BRAKE	060301	2	0
N	F3AZ	2001	A	KIT-BRAKE SHOE LININ	NANANA	1	0
N	F1VY	2C026	A	ROTOR-RR WHL DISC BK	NANANA	2	0
N	F2VY	2200	A	SHOE LINING REAR BRA	NANANA	1	0

Any comments? You can contact



webmaster@aws-ford.com

DESCRIPTION AND OPERATION (Continued)

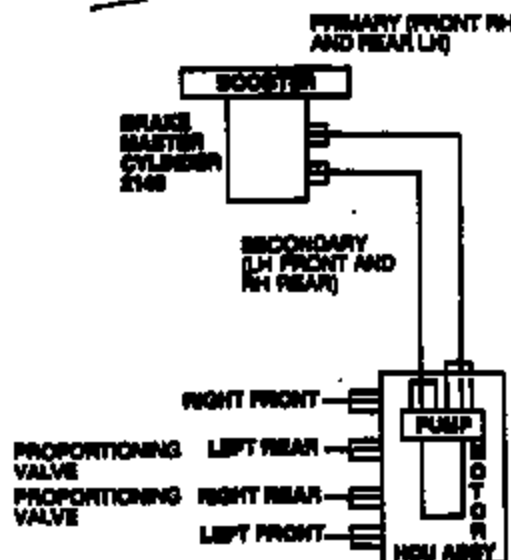


Item	Part Number	Description
1	—	Field Level Indicator (Part of 2C246)
2	2C234	Low Pressure Hose
3	—	Pump (Part of 2C256)
4	2C256	Pump Motor
5	—	16-Pin Connector (Part of 2C256)
6	—	4-Pin Connector (Part of 2C256)
7	2C256	Brake Pressure Control Valve Block
8	2C246	Hydraulic Control Unit Reservoir

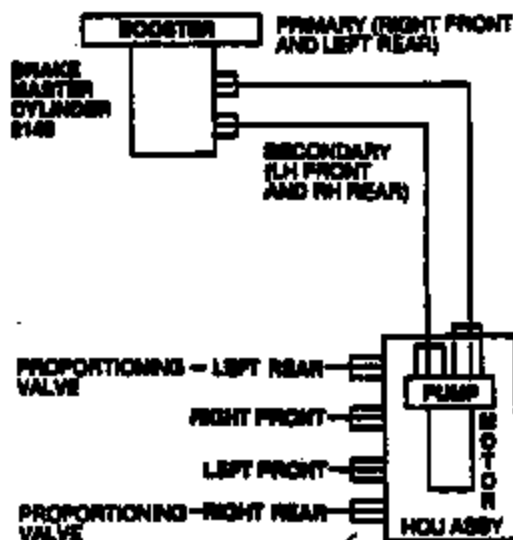
The Town Car ABS only anti-lock hydraulic control unit is six inches long; the ABS with TA anti-lock hydraulic control unit is eight inches long. Also the ABS with TA valve body has two additional wires. They are located in Pins 5 and 6 in the connector on the HCU 16-pin connector. All Town Cars have these two extra wires on the harness side connector. If the vehicle is equipped with ABS only, the two extra wires on the harness side connector will align with empty holes on the HCU connector.

Hydraulic Schematic

ABS with Traction Assist

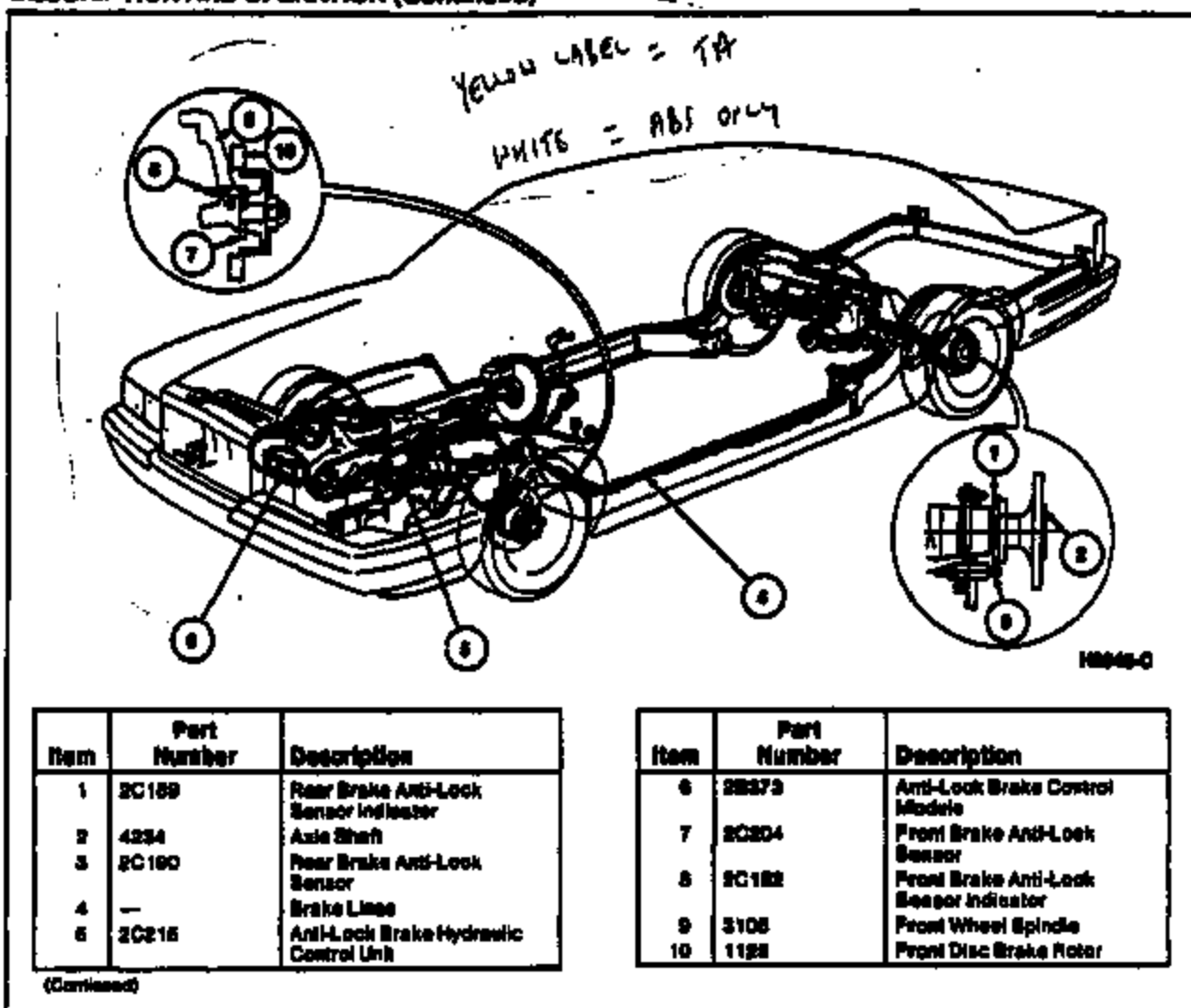


ABS Only



Closest to Radiator

DESCRIPTION AND OPERATION (Continued)

**System Relay**

The anti-lock brake control module controls the operation of the following:

- Anti-lock power relay.
- Anti-lock brake motor relay.
- Anti-lock brake indicator.
- Anti-lock brake valve assembly.

The anti-lock power relay is grounded by the anti-lock brake control module to power up the system. The anti-lock brake control module also grounds the anti-lock brake motor relay to run the hydraulic pump motor when the anti-lock brake pedal sensor switch is open during anti-lock cycling.

System Diode

The system diode allows electrical current to flow in one direction only. It acts as a short circuit in one direction and open circuit in the other direction. This diode enables the four-wheel ABS warning indicator to illuminate when the ignition switch is in RUN and the system is disabled by switching the system relay to the default position.

Name / Project BP Switch / Town Car Testing
 Company / Department @ MPG
 Address _____

Phones

DATE TIME SEQ. MY PLAN / I SAID NEEDS EXPRESSED / FEEDBACK SOUGHT THEY SAID / FOLLOW-UP NEEDS EXPRESSED / FEEDBACK GIVEN WHEN DATE

3/9/99

8 AM

Joe & Dennis observed that Brake Fluid is leaking out of reservoir. ~~under the~~ The fluid is noticeable on the upper edge of the plastic ~~seam~~ seams of the reservoir. I observed the same on 3/2/99 after testing was completed that day. Dennis checked it several times on Thursday 3/4/99 during testing. ~~During that~~ During that test there was not observed fluid. This morning the fluid ~~was~~ observed again. The vehicle has not been used since testing on 3/4/99. At the conclusion of testing on 3/4/99 there was no observable fluid (per Dennis). There are no obvious cracks or holes in the reservoir.

Testing today... will be on low mu.

et.

i.

Brake Pressure Switch On Vehicle Characterization

Updated 2/26/99

Vehicle: 1992 Town Car

With ABS
With Traction Control
No Major Modifications
No Issues with Brake System

Parameters to be Measured

Pressure Profile at Brake Pressure Switch Mounting Location on Proportioning Valve
Brake Fluid Temperature at same location
Ambient Temperature at same location
Pressure Profile exiting ABS unit prior to entering Proportioning Valve
Brake Pressure Switch circuit (orange wire) voltage.
Vehicle Speed
Brake Pedal ON/OFF switch Voltage
Brake Pedal Effort

Pressures up to 250 Bar, sampling rate 1000 hz minimum.
Voltage up to 30 Vdc
Temperature -10 to 300 F
Effort 0 to 400 lbs

Driving Conditions

DO NOT USE SPEED CONTROL

Traction surface : Dry Asphalt

Loading = 2 Pass weight

	Speed mph	Pedal effort	decel G	repetitions	rate/mile
Normal Braking (no ABS)	0	normal		5	
	30		< 0.3	5	1
	40		< 0.3	10 5	1
Normal Braking + ABS	30		0.7 - 0.85	5	1
	40		0.7 - 0.85	10 5	1
Panic Braking (No ABS)	40	aggressive		10 5	1
Panic Braking + ABS Traction Control On Other combinations	40	aggressive		10 5	1

Vehicle Information Report

GENERAL VEHICLE INFORMATION:

(Related Claims)

VIN: 1LNLM2W8P	Veh. Line	CVB - TOWN CAR (FWD/FN116) (91-97)	Eng. Serial No: W
Model Year: 1993	Market Derivat:	C/M - L-M DIVISION DERIVATIVE	Body Style: *
Veh. Type: C	Drive Code:	C/B - 2 WHL L/H REAR DRIVE	Engine: CVN - B-M 4.6L SOHC EFI NA
Inv. Dealer: 13928	Body Code Style:	CFC - 4 DOOR SEDAN-6 LITE	Transmission: CDE - 4 SPD AUTO TRANS-NA
	Variant/Option:	C/EK - SIGNATURE VERSION	

BUILD INFORMATION:

Region: NA - MINNESOTA Plant: BA - WIXOM PLANT BUILD
Country: USA - MINNESOTA Prod Date: 02-SEP-1992

SALE INFORMATION:

Region: NA - MINNESOTA Selling Dealer: 345345 - *
Country: USA - MINNESOTA Selling Dir. S/Prov: MI
Buyer S/Prov: MI

Arrival Date: 01-SEP-1992 Red Carpet Lease: *
Sale Date: 01-MAR-1993 Fleet/State/Co. Lease: R
Warranty Start Date: 01-MAR-1993 Modified Vehicle: *
Orig. Warranty Date: 01-MAR-1993 Reregistered Vehicle: * Vehicle Export Flag: N

VOC/EOC:

-----1-----2-----3-----4-----5-----6-----7-----8-----9-----
M82PTE14173 45 2 24H5023 AM D RTY 3PA 4 2 L6 P 45A345 3 DF D6 H M1
MLR 1 D 755A MP

Standard Claims List For Model Year 1993

ILNLMB2WSPY	CVB	C/M	CFC	C/R	C/B	BA	C/DK	C/VN	02-SEP-1992	01-MAR-1993	345345	USA	7	7204
AWS Claim Key:	2796447	Trx Code:	1	Labor Hrs:	.6	Labor Cost:	33.89	Material Cost:	177.66	Total:				
Dir Cd-Sub Cd:	13928-*	Name:	STU EVANS LINC-MERC INC-GDNCTY			Phi:	313-4234300	Str MI:		Qty Cd:	USA	Reg Cd:		
<i>Santa</i>														
ILNLMB2WSPY	CVB	C/M	CFC	C/R	C/B	BA	C/DK	C/VN	02-SEP-1992	01-MAR-1993	345345	USA	16	5703
AWS Claim Key:	2796448	Trx Code:	884	Labor Hrs:	1.3	Labor Cost:	67.39	Material Cost:	337.89	Total:				
Dir Cd-Sub Cd:	13928-*	Name:	STU EVANS LINC-MERC INC-GDNCTY			Phi:	313-4234300	Str MI:		Qty Cd:	USA	Reg Cd:		
<i>Brake Vib & Shifter - replace 5 ho-on: 3 DISC X 4</i>														
ILNLMB2WSPY	CVB	C/M	CFC	C/R	C/B	BA	C/DK	C/VN	02-SEP-1992	01-MAR-1993	345345	USA	32	7903
AWS Claim Key:	13466443	Trx Code:	883	Labor Hrs:	.4	Labor Cost:	23.92	Material Cost:	32.07	Total:				
Dir Cd-Sub Cd:	13928-*	Name:	STU EVANS LINC-MERC INC-GDNCTY			Phi:	313-4234300	Str MI:		Qty Cd:	USA	Reg Cd:		
<i>TECH COMMENTS: REPLACE DOOR BEZEL NO OPERATION. 1 DOOR 274L</i>														
ILNLMB2WSPY	CVB	C/M	CFC	C/R	C/B	BA	C/DK	C/VN	02-SEP-1992	01-MAR-1993	345345	USA	32	6X06
AWS Claim Key:	13466444	Trx Code:	884	Labor Hrs:	.9	Labor Cost:	53.22	Material Cost:	100	Total:				
Dir Cd-Sub Cd:	13928-*	Name:	STU EVANS LINC-MERC INC-GDNCTY			Phi:	313-4234300	Str MI:		Qty Cd:	USA	Reg Cd:		
<i>1 DOOR 274L</i>														

Any comments? You can contact



webmaster@guv-ford.com

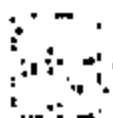
INSTALLED OPTION INFORMATION:

Air Conditioning:	C/C -A/C AIR CONDITIONER	GVW Code:	-
Alternator Amp Rating:	*	GVW Class Code:	L
Audio Basic:	* - [N/A]	Instrumentation:	AC - ELECTRONIC INSTRUMENTATION
Axis Ratio:	EGACC - 3.06 FINAL DRIVE RATIO	Mirror(Driver Side):	* - [N/A]
Axis Type:	EGIAC - LIMITED SLIP REAR AXLE	Mirror(Passg Side):	* - [N/A]
Battery Amp Rating:	72	Paint:	PNMDF - MED AQUAMARINE CC
Brake Code:	FEAAB - 4 WHEEL ANTI-LOCK BRAKES	Power Antenna:	* - [N/A]
Brake Code(Serv):	* - [N/A]	Radiator:	AQ - ELTRA PREMIUM AM/PM STROKSTE
Calibration Code:	318R10A	Sound System:	* - [N/A]
Color(Account):	* - [N/A]	Susp Tandem Axle:	* - [N/A]
Color(Trim):	000YD -	Tire Brand:	AJ - MICHELIN TIRE VENDOR
Delivery Type:	0	Tire Size:	DGGEF - P215/70R13 WSW
Drivetrain Code:	*	Traction Control:	* - [N/A]
Front Seat:	* - [N/A]	Wheel Base:	* - [N/A]
Fuel Type:	* - [N/A]		

ESP INFORMATION: EMISSIONS INFORMATION:

ESP Code:	* Engine Code:	CB - CB
ESP Coverage(Miles):	* Emission Cert Type:	F
ESP Coverage(Time):	* Emission Descr Suffix:	JY
ESP Plan Year:	* Engine Family:	9FM46V3FDF2
ESP Signature Date:		

Any comments? You can contact


webmaster@aws-ford.com

M

3713 2048

* Note printed by SREIMERS on 25 Feb 1999 at 10:21:51 *

From: DBAUNE3 --DBSN005
To: SREIMERS--DBSN007

Date and time 02/25/99 09:39:01

FROM: DAVID BAUER

USANT(UTC -05:00)

Subject: Brake fluid switch ignition

Thinking about the switch ignition problem, it occurs to me that if the problem is a short between the contact spring and ground, one possible fix would be to coat the cup with an insulating epoxy coating. This should prevent any bridging of corrosion products from spring or rivet that would lead to high current draws and melting of the plastic. Leaking of fluid might still result in a switch failure, but there would not likely be a possibility of fire. Just a thought.

. Regards,

Dave Bauer (dbauer3) x41756

Regards,

DAVID BAUER

3713 2047

RELOCATE SWITCH
TO BRAKE PEDAL

2/17/99

Need 92/93 TC to
make-up internal Deac-Switch.

Rework

- ① 16 WAY - Pull 2 ~~Plugs~~ terminals
Plug open holes
with terminated
jumper.
- ② Pull two wires thru Grommet
with terminals.

(Mating connector to Deac-Switch
to Charles Flynn UTA

- ③ Put two wires into 2 way
- ④ Connect to 2 way jumper
to New Deac-Sw.

INVOLVED Re-taping
16 WAY TAKE-OUT BUNDLE

MARTY WORKING
ON SWITCH PKG

Mat'l

Jumper Plug

Jumper 2 Plug
to New Switch

New Switch

Tape

PLUG FOR BRAKE SW
TO BE USED FOR SW

PARENT

BRAKE
LAMP
CIRCUIT
(VBAT)

15A

STOP LAMPS



NC
BRAKE SWITCH



EM
CLUTCH



CRUISE
CONTROLLER



2/99

11
AZ12

PROPOSED

BRAKE (VBAT)
LAMP
CIRCUIT

MINIMIZE
ACTIVATION
TO REDUCE
WEAR & WELD
N/O
RELAY



7.5A
RELAY

CRUISE
CONTROL
INPUT
OR
IGN RUN
OR
TRANS TWT
OR
HORN RELAY



NC
BRAKE SWITCH



EM
CLUTCH



CRUISE
CONTROLLER



Red coil
Is this
acceptable

3713 2049

REVISION 001 10-12
REVISION 002 10-12
REVISION 003 10-12



ENC

3713 2050

COMMUNICATIONS

Name / Project: MARK McAlees / DOW FAIRLEY
 Company / Department: DuPont
 Address: OHIO FAIRPORT

Phone: 740-470-0725

DATE: 1/28 BY: MARK RE: MARK / MARK

What is Delamination Temp? FE 1/2 pt 268°C (519°F)

How can I induce brittleness? Two days Chemical/Temperature
 (IN KAPTON) 240°C (464°F) 100% Hr 502
350°C 6 days 12 450° 2 hours 12 KAP

Corona Treatment Started? 25 years

Processing changes? Nothing
Definitely not in the 1990s

Has there been any changes to materials composition or manufacturing process since 1990? 1983-4 INORGANIC POLYMER ADDITIVE
AD45 PMDA 1963 release
no changes

ADDITIONAL INSPECTION
 500 HN EN131L for Auto? Yes 15/90 years

Is it suitable for use with DOT3 Brake Fluid? ethylene glycol
on FE 1/2 pt 300°F
no degradation

Is there test results for Brake Fluid contact? 11

MARK TO CALL BACK 1/28
 WITH CHANGE HISTORY etc.

COMMUNICATIONS

Name / Project

DAN KULKARNE

Company / Department

UTA → LEAR

Address

Phone

3/31/99

DATE
TIME

NO.

DE PLAN / LEAD
NORM EXPENSE / FEEDBACK SCORE

THEY HAD / FOLLOW UP

THEY HAD / FOLLOW UP

DATE

NOON

WAS THERE ANY

E45B-14603-AA

OTHER MATERIAL

WIRE GROMMET & NO ALTER-

USED FOR THE

NATE MATERIAL USED.

WIRE GROMMET?

FOR OUR CONNECTOR

ASSEMBLY.

COMMUNICATIONS

Name / Project SCOT DUDLEY

Company / Department _____

Address _____

Phone _____

21687

DATE

NO.

BY PLAN / LAB

NEEDS EXPRESSED / FEEDBACK SOLICIT

THEY HAD / FOLLOW-UP

NEEDS EXPRESSED / FEEDBACK GIVEN

WHEN

DATE

3PM 3/30/99

NEED SOMETHING TO
ENCLOSE BR SWITCH
2. CONTAIN FIRE

- Metal Box enclosure
with overlapped seams.
1/16 INCH GAPS
- Soft Stamping of Aluminum
(~ 3 weeks lead time).

- GOOD TO ABOUT 1000°F

- Brake Fluid is a
complication. It
ignites readily when
atomized.

Is tape possible?

- Aluminum tape is
available. Adhesive
life is not much
more than a few months.

- Lubri-sol (sp?) frame wax
coating may be an
addition fuel. Enclosed
of

- E-Coated frames are
not flammable.

Source for Soft Stamping-

LYDALL
FRANK BURGHOUS
248-952-5570

NOTE: LIKELY THAT AN ENCLOSURE WILL MAKE
IT DIFFICULT TO DETECT BF LEAK. *SR*

COMMUNICATIONS

Name / Project

PAUL KANE

Company / Department

DUPONT

Address

248-583-8107

Phones

DATE
TIME

SEC

MY PLAN / TASK

NEEDS EXPRESSED / FEEDBACK GIVEN

THEY LIST / MY COMMENTS

THEIR COMMENTS / FEEDBACK GIVEN

DATE

10:15

4/1/99

Tele con 1 Greg Stearns

VØ PRODUCTS

WILL CONTINUE

TO BURAN WHILE HEAT

SOURCE IS PRESENT.

SELF EXTINGUISHES.

- Zenite 6140 L

40 Glass LCP

FORD APPROVED ON WASHER SYS

IS VØ ~600°F Melt Point

- Zytel HTN 52G 35 FR

NOT FORD

IS VØ ~540°F Melt Pt

PAUL Scheduling date
sheetsI CALLED TI and asked them
to look into Zenite 6140 L

Zytel sample tried at TI.

3713 2055



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Garry L. Jackson
Delphi Chassis Systems

Pierre Lévesque
Union Carbide Corp.

Frederick T. Wagner
General Motors Research & Development Center

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Improved Methods for Testing the Durability of Corrosion Protection in Brake Fluids

Garry L. Jackson
Delphi Chassis Systems

Pierre Lévesque
Union Carbide Corp.

Fredrick T. Wagner
General Motors Research & Development Center

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ABSTRACT

Present corrosion testing procedures for brake fluids assess the properties of fresh fluids under some forms of environmental stress (e.g., water content, elevated temperature). These tests may not accurately predict corrosion protection properties of fluid after the years of continuous service typical of North American practice. This paper describes the development of laboratory accelerated aging procedures which reproduce the chemical changes occurring in brake fluids during long-term service. Short-duration vehicular tests with these lab-aged fluids have reproduced specific modes of corrosion previously observed only after long-term customer use.

INTRODUCTION

Brake fluid reliably transmits full boosted pedal pressure throughout the braking system. Brake fluid also serves to protect against corrosion the brake system materials it contacts. While in Europe the brake fluid in a vehicle is typically changed every few years, in North America brake fluids are not routinely changed. Therefore, it is important to assess the long-term corrosion protection of brake fluid used in cars and trucks sold in North America.

The minimum levels of corrosion protection required for brake fluids are set by laboratory test procedures embodied in FMVSS 116¹, a regulation based on the primary brake fluid standard for the automotive industry, SAE J1703². The corrosion tests required by these standards are performed on fresh samples of brake fluid and may not be a reliable

indicator of the level of corrosion protection afforded by the fluid after several years in a vehicle. A fluid compounded from high-quality base materials, but containing no corrosion inhibitors whatsoever, can pass the weight change requirements (see Table 1). Corrosion is on occasion still observed within brake systems filled with fluids which were fully compliant with SAE J1703 and FMVSS 116 when fresh. Chemical analysis of used brake fluids suggests reasons why corrosion could occur in these circumstances.

Table 1: J1703 corrosion test (section 4.6) weight changes for an uninhibited brake fluid base.

metal	J1703 max. wt. change (mg/cm ²)	measured wt. change (mg/cm ²)
Tinned iron	±0.2	-0.04
Steel	±0.2	-0.04
Aluminum	±0.1	+0.01
Cast iron	±0.2	+0.00
Brass	±0.4	-0.02
Copper	±0.4	+0.00
Zinc	±0.4	+0.06

Note: J1703 4.6 requirements on copper and fluid appearance, sediment, and rubber interactions also passed

This paper first characterizes, through chemical analysis, the changes which can occur in brake fluids during vehicular use. Then, building upon this database, we develop new aging and testing procedures which can measure the durability of the corrosion protection provided by a fully-formulated fluid. The primary corrosion inhibitors used in most brake fluids are amines, organic bases which both provide general buffering

capacity against the deleterious effects of acidic breakdown products and provide specific protection of particular metals, presumably through adsorption. Amine both work well as inhibitors and fulfill the extended solubility constraints posed by the need for the brake fluid to remain a single phase system over wide ranges of temperature and water content. This paper will therefore concentrate upon the amine components of the total inhibitor package.

SPECIAL STRESSES AND REQUIREMENTS OF ANTILOCK BRAKE SYSTEMS - Modern antilock brake systems pose new challenges to the proper integration of formulated brake fluids into total brake system design for durable performance. The increased circulation of brake fluid associated with ABS (e.g., through low-pressure return lines to the master cylinder reservoir) may increase the chances of loss of brake fluid components from the fluid, either by direct evaporation, permeation through polymers, or sorption into polymers. The forced circulation can also facilitate the transport of corrosion products and/or thermal degradation products, if they are present, from one point in the brake system to another.

CHANGES IN BRAKE FLUID CHEMISTRY DURING VEHICULAR SERVICE

DROP IN RESERVE ALKALINITY - The amine inhibitors which provide the primary corrosion protection in most brake fluids are organic bases. A simple approximate measurement of their total concentration (and the stability of) in a formulated brake fluid can be obtained by acid-base titrations similar to those called out for engine coolants by ASTM standard D 1121³. The Reserve Alkalinity (RA) of a brake fluid is defined as the number of milliliters of 0.100 M hydrochloric acid needed to titrate 50 ml of brake fluid down to a pH of 5.5⁴ (in contrast, the D 1121 definition of RA for engine coolant is ml HCl / 10 ml coolant concentrate). In an attempt to keep all brake fluid components in solution during the titration, the brake fluid is prediluted with a solution of 50% denatured alcohol and 20% deionized water (in this work, ~2ml of brake fluid [quantified by weight] was diluted to 60 ml total volume before starting titration with 0.100 M HCl). RA's of fresh brake fluids in recent commercial production range from about 3 to about 120.

Figure 1 shows the residual RA (as % of initial value) of a brake fluid in matched vehicles 0-3.5 years old, plotted as a function of the age of the fluid. By 36 months (about 50,000 km) the RA has dropped to as low as 9% of its initial value, and about half of this small residual RA arises from components other than the amines. The titration data therefore suggest a 20-fold reduction in primary inhibitor concentration over 2-3 years of service.

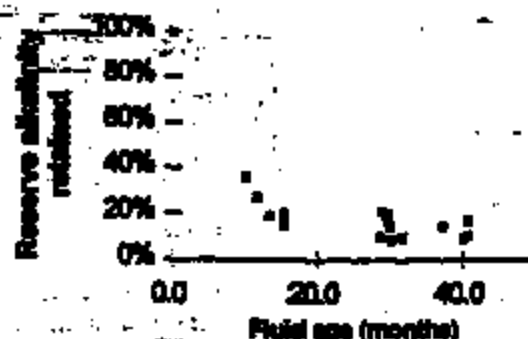


Figure 1: Decrease in reserve alkalinity of a brake fluid during vehicular use.

Table 2 shows %RA (vs. fresh values for appropriate OEM brake fluids) for a number of fluid samples taken from randomly-selected vehicles produced by a range of manufacturers. Some loss of RA during vehicular service is universally observed, but the % retained varies widely for different fluids. In the absence of further data, no conclusions about the quality of corrosion protection afforded by a fluid should be drawn from absolute RA values, since it may be possible to formulate effective fluids with a wide range of initial RA's. However, the evaluation of the RA over time of use gives a general picture of the stability of the inhibitor package. If the material retains a smaller percentage of its initial RA over time, one can have less confidence that the initial level of corrosion protection implied by J1703 compliance will be continued through the service life of the vehicle.

Table 2: Retained reserve alkalinity for a number of OEM fluids after vehicular use.

OEM fluid	Kilometers	Months (approx.)	% initial RA retained
I	73830	36	9%
II	71667	36	21%
III	47618	na	33%
IV	117762	36	40%
V	60780	na	32%

DROP IN AMINE INHIBITOR CONCENTRATIONS, BUILDUP OF INHIBITOR REACTION PRODUCTS, AND LOSS OF TOTAL NITROGEN - Determination of RA, while simple, actually measures only general buffering capacity, not the concentrations of particular inhibitors. To properly characterize the chemical evolution of brake fluids in use and to prevent misinterpretation of RA data, it is necessary to be able to quantify the concentrations of individual inhibitors. The capillary gas chromatographic (GC) techniques employing flame ionization detectors (FID's) commonly used in quality control of the glycol ether and polyglycol components of brake fluid base can, if carried out with unusually high resolution, quantify the presence of at least some of the common amine inhibitors. However, since the

amines constitute only a small fraction of the total fluid and the chromatographic properties of some important amines are less than optimal for clean separation. Full characterization of amine content requires methods which are more selective for nitrogen compounds.

One successful approach has been to use capillary GC with a thermal conductivity detector (or nitrogen-phosphorus detector (NPD)) which has a sensitivity for nitrogen atoms in molecules which is over 5000-fold greater than its sensitivity for carbon atoms⁴⁴. This high selectivity for N allows not only ready identification of the chromatographic peaks due to the original amines but also allows one to determine the fate of nitrogen atoms as the original amines react to form new nitrogen-containing compounds during vehicular use. This ability to monitor nitrogen in the fluid even after it has been incorporated into reaction products which may no longer provide buffering capacity has proven particularly useful in tuning laboratory aging procedures to accurately reproduce the effects of extended vehicular use.

Total nitrogen in the brake fluid was also measured with a standard N/S elemental analyzer. Since this technique is sensitive to nitrogen in any relevant form, the drop of total nitrogen as seen by this method allows determination of what fraction of initial nitrogen completely left the fluid. In the primary fluids under study here, the overwhelming preponderance of original nitrogen in the fluid was in the form of the amine inhibitor(s).

Capillary electrophoresis was found to be another successful analytical approach for the amines in most of the inhibitor packages⁴⁵. The technique relies on the fact that ions move with different velocities through a capillary tube filled with buffer solution when an electric field is applied across the length of the tube. Amines in aqueous solutions of brake fluid were separated and detected as their ammonium cations in a pyridinium sulfate buffer at pH 4.4. When they passed through the UV absorbance detector on the Capillary Ion Analysis (CIA) instrument, amine cations were detected as a decrease in absorbance at 254 nm because they displaced some of the pyridinium cations which absorb light at that wavelength⁴⁶. For many fluids, this procedure detects all of the original amines and any reaction products thereof which retain basicity. However, it will not detect other nitrogen-containing reaction products which do not still contribute to the buffering capacity of the used fluid. The limited aqueous solubilities of the ammonium ions derived from the inhibitors in some fluids can lead to irreproducible CIA results. Consequently, the NPD GC and CIA methods were used together to generate corroborative and complementary data.

The mechanisms by which the amine content decreases over time can be inferred by comparison of several metrics of a fluid after vehicular use: the % RA retained, the % retained of total original amine species (by NPD GC), the % of total nitrogen retained (by N/S), and the % buildup of known N-containing reaction products which do not provide buffering capacity (by NPD GC). While the RA and the concentrations of the original amines drop away after approximately 75000 km to <10% of their initial values, more than a third of the original total nitrogen remains in the fluid. Essentially all of this residual N is in a form other than the original amines, and most of the residual N is in a form which does not provide

significant buffering against addition of acid. Of this undissolved but still-present portion of the N, approximately half can be identified as a particular reaction product, the formamide of an inhibitor originally present in the fluid. Cast iron readily rusts when placed in contact with unleaded brake fluid base to which an appropriate level of this formamide, 5% water, and 50 ppm chloride were added. When the original amines replaced the formamide in control experiments, no rusting was observed at all. The formamide reaction product thus serves neither as a buffer nor as a corrosion inhibitor. However, it does provide a readily-analyzed signature for the severity of thermal oxidation to which a fluid has been subjected while being used in a vehicle.

INCREASE IN DISSOLVED METALS - Measurements of dissolved metals in brake fluid (here, done by inductively-coupled plasma atomic emission spectroscopy) provide an indirect indicator of corrosion activity within the brake system. If such measurements are to be a useful guide to the functional durability of the fluid, they must both be interpreted with some care and be accompanied by detailed inspection of brake system components to establish whether the presence of the dissolved metals in the fluid is in fact indicative of a condition which could eventually decrease brake system performance. A low rate of general corrosion over a large surface area of a metal may lead to apparently significant levels of that metal dissolved in the fluid but may pose no threat to system performance. Conversely, a very high rate of localized corrosion of a metal could produce only a small dissolved metal content in the fluid but eventually lead to significant loss of brake system function. A case of correlation between metals uptake in the fluid and component corrosion with a potential for functional significance over an extended service life will be given in later sections of this paper.

Figure 2 shows the pickup of metals by a fluid in vehicular service as a function of fluid age, corresponding to distances traveled of 0-100,000 km. In all vehicles in this figure and for all fluid ages, the metal at highest concentration in solution is copper. This is in part due to the (perhaps surprisingly) huge preponderance of the system surface area exposed to the brake fluid which is copper. The interior of typical 2-layer steel brake pipe is completely covered by the copper brazing alloy. A typical light-duty vehicle uses 14 m of such pipe, with an internal diameter of ~2.5 mm, giving an internal geometric surface area of 1200 cm². Atomic force microscopy scans of the interior copper surface of the pipe yield a roughness factor of 1.5, so that the ~900 ml of brake fluid in a vehicle (including that in the master cylinder reservoir) is exposed to 1800 cm² of copper. The approximately 200 ppm of Cu seen in the brake fluid after ~36 months corresponds to dissolution of ~0.1 mg/cm² copper in 3 years of service, compared with the 0.4 mg/cm² copper allowed in a 5 day laboratory test to comply with J1703. The copper corrosion, which appears to be general (rather than localized) in morphology, poses no direct threat to system integrity.

The significance of Figure 2 lies not in the relatively large dissolved copper levels but in the more subtle levels of dissolved iron. No dissolved iron at all is seen until around 30 months, after which 30-100 ppm of dissolved iron becomes usual. Cast iron components removed from some vehicles at such times show some level of pitting of the iron, with pits typically surrounded by metallic copper.

Dissolved iron appears in the brake fluid after the initial anodic corrosion inhibitors are significantly depleted and dissolved copper levels rise to around 200 ppm. The apparent induction period for iron corrosion has presented difficulties in testing technological changes designed to minimize this effect; no test protocol employing fresh brake fluid had succeeded in reproducing the iron corrosion observed at times in vehicles after several years' service. Later sections of this paper will show that attention to the chemical changes in brake fluid during use has led to test procedures which reproduce the field vehicular effects within 6 months.

The dissolved zinc levels in Figure 2 show no evidence of the induction time seen for iron. Since testing for corrosion protection of zinc in brake fluid is known to be problematic even in fresh brake fluids¹⁰ (it is not yet a requirement of FMVSS116), it would not be entirely surprising if some Zn corrosion is occurring even after relatively short service. Another possible source of the observed zinc is extraction of Zn compounds from hoses.

Table 3 shows dissolved metal data for different fluids after extended use in vehicles built by a number of manufacturers. Analytically significant levels of dissolved metals are a common, but not completely universal, characteristic of brake fluids in vehicular service. Between different vehicles, the metals dissolved in brake fluid can be expected to vary with the metals exposed to brake fluid and the service conditions, as well as with the properties of the brake fluids used.

Table 3: Dissolved metals for a number of OEM fluids after use in vehicles.

Fluid	Iron (ppm)	months (approx)	Cu (ppm)	Pb (ppm)	Zn (ppm)
a	4391	28	30	<10	10
a	57783	28	150	10	0
a	77371	40	230	110	50
b	6134	12	30	<10	10
b	60717	na	300	<10	130
b	na	60	530	30	200
c	47619	na	260	30	140
d	71004	36	18	2	49
e	106612	24	16	3	33

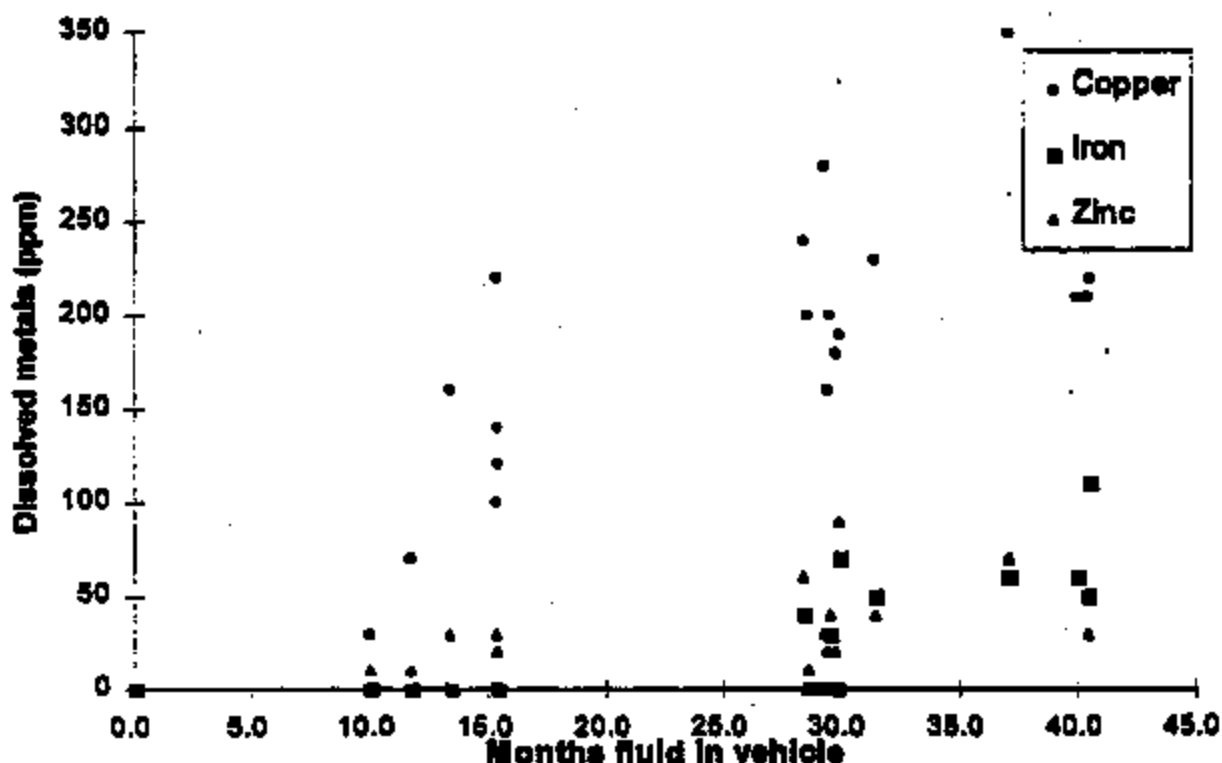


Figure 2: Dissolved metals in a fluid as function of time of use.

LABORATORY AGING PROCEDURES

Analysis of changes in reserve alkalinity, concentrations of initial amines, concentrations of identifiable nitrogen-containing reaction products, and total nitrogen with vehicular use point to at least two pathways for loss of buffering capacity and amine inhibitor action in brake fluids over time. Under conditions where the buffering capacity is almost completely lost, total nitrogen measurements show retention of 35-45% of the original nitrogen in the fluid (in a formulation for which the vast majority of initial nitrogen is in the amine inhibitors). Thus 1/3-1/2 of the initial nitrogen remains in the fluid but has been converted to non-buffering compounds which are also not good inhibitors. About half of this now-inactive nitrogen can be accounted for by the growth of the formamide derived from an initial amine inhibitor. The chemical path to a formamide is reasonably clear. One end of a glycol ether base fluid molecule can dissociatively oxidize, breaking off one carbon atom to yield formate, a common oxidation product of glycols and glycol ethers. The formate can then react with amine molecules to form inactive formamide molecules. The large concentrations of formamide products which develop during vehicular service thus point to thermal oxidation as one significant cause of the changes of brake fluid chemistry seen in vehicles.

The other significant change in fluid amine chemistry involved not conversion of nitrogen to an inactive form, but loss of nitrogen (in any form) from the brake fluid. The selective loss of various amines from brake systems suggested that volatility, either directly from the fluid surface in the master cylinder reservoir or indirectly via permeation through hoses, could be the second major pathway to the loss of amine inhibitor activity in vehicles. These two pathways to amine loss were incorporated into a laboratory aging procedure designed to mimic vehicular behavior.

THERMAL OXIDATION - The thermal oxidation aspect of brake fluid aging was examined in the laboratory by an 18 hour air-sparged reflux of the fluid at 132° C in the presence of copper powder. To gain maximum acceleration of the aging process, it was desirable to run at the highest temperature which fluid was likely to see anywhere in vehicular brake systems under conditions occurring during normal driving. The chosen 132° C is the highest temperature allowed for fluid during a standard vehicular service test. Copper powder (at $>2 \text{ cm}^2 \text{ Cu}$ per ml brake fluid) was incorporated into the procedure because of the similarly high Cu surface / brake fluid volume ratio in real brake systems, the observed dissolution of Cu into fluids during use, and the known behavior of Cu as a catalyst for the oxidation of organic compounds¹¹. The duration of the laboratory oxidation treatment was sufficient to approximate the levels of formamide reaction products seen in vehicular brake fluid samples after 3 years' service.

Refluxing of 2 liter quantities of fluid was carried out in a 3000 ml round-bottomed flask with three 24/40 tapered glass joints (two fixed and one adapted), warmed with a heating mantle. A water-cooled 300 ml - long Graham (oil) condenser in series with a 300 mm - long Allihn (bulb)

condenser (the latter on top) proved adequate to keep total weight losses for the fluids below 0.5% during this procedure. Air (free of carbon dioxide and hydrocarbons) was sparged through the fluid at 10 ml/min through a fluorinated ethylene-propylene (FEP) tube drawn out in the hot air of a heat gun to give a ca. 1 mm opening. Temperature was measured by a 0.13 mm thermocouple within the fluid and was controlled with an Omega BE3001 temperature controller switching the power to a variable transformer set at 70 V (for steady-state operation) which in turn supplied power to the heating mantle. The fluid and 80 g of copper powder (Baker 1728-01) were continuously stirred with a magnetic stirrer directly below the heating mantle. A 18-20 cm² piece of cast iron brake cylinder was used as a stir bar and provided a quick visual check of any corrosive effects generated during the thermal oxidation; a second standard polytetrafluoroethylene-coated stir bar was also put in the flask to improve stirring. The fluid was refluxed in the flow of air for 18 hr at 132° C in this apparatus. Then the fluid was decanted from above the copper powder and transferred to a 4 liter borosilicate glass beaker for the next step of the laboratory aging process.

The white columns of Figure 3 show the % RA retained after SAE compatibility fluid RM-66-04 and a number of commercially available brake fluids were subjected to this thermal oxidation procedure. Results range from >90% retention of buffering capacity to complete destruction of buffering capacity (pH below 5.5 after thermal oxidation [not shown]). While DOT 4 fluids taken as a class were more resistant to loss of amines and buffering capacity by thermal oxidation, some DOT 4 fluids showed some of the lowest levels of thermal stability seen in any fluids.

Significantly smaller RA losses were observed when argon was substituted for air in this procedure or when fluid was simply sealed into brake pipe and heated. Nitrogen analysis of fluids subjected to this air-sparged reflux procedure showed very little loss of total nitrogen. The primary mechanism of loss of buffering capacity tested by this procedure therefore appears to in fact be thermal oxidation.

VOLATILIZATION - The simplest process which could explain the observed 35-65% loss of total nitrogen from some brake fluids during vehicular service is volatilization of amines either from the free surface in the master cylinder reservoir or after permeation through hoses. Another possibility is simple absorption into hose materials without evaporation off of the hose outer surface. Since simple volatilization of the amines off of the free fluid surface can be performed more reproducibly in the laboratory, direct evaporation was chosen as the initial laboratory procedure to simulate the observed vehicular loss of total nitrogen from the fluid.

The tendency of fresh fluids towards loss of amine inhibitors through volatilization can be quickly measured largely in isolation of other effects by placing 100 ml of fluid into a standard SAE corrosion test jar which is then placed, uncovered, in an oven at 160° C for 16 hours (temperature chosen for convenience to a lab running standard corrosion tests). Figure 4 shows how the RA drops for various fluids as a function of time under these conditions. However, this simple volatilization experiment alone does not accurately

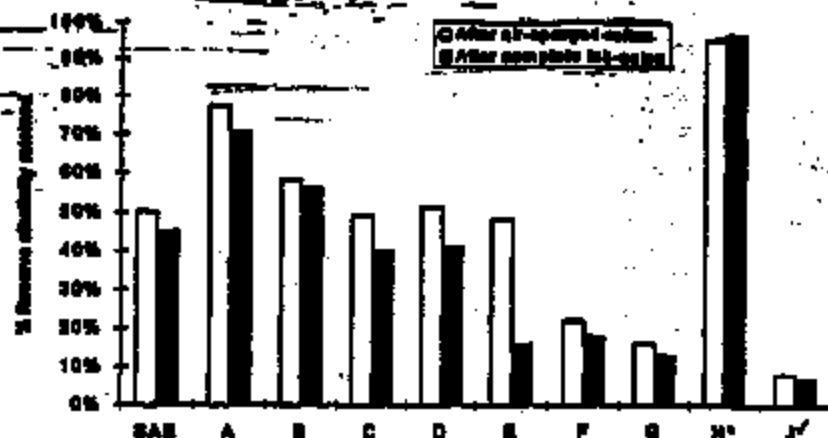


Figure 3: % Reserve alkalinity retained after thermal oxidation and after complete lab-aging procedure were applied to SAE compatibility fluid RM-66-04 and commercially available fluids (* indicates DOT 4 fluid).

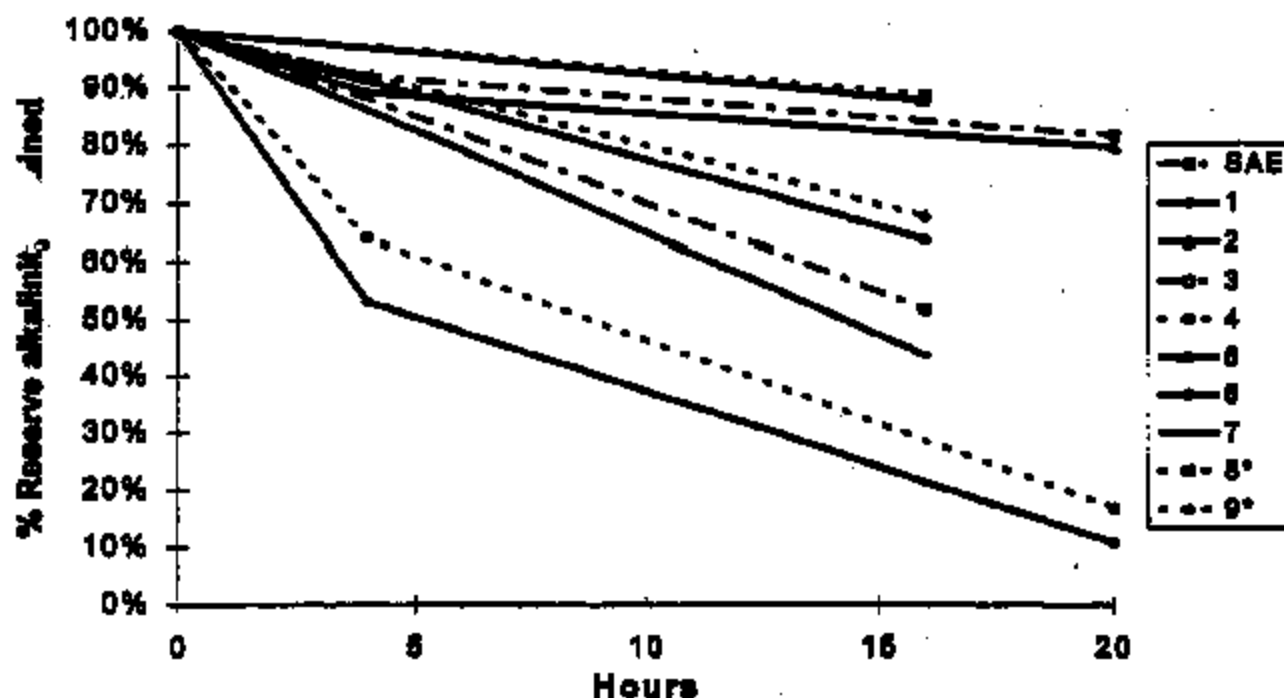


Figure 4: Reserve alkalinity retention as function of heating time (uncovered) at 150°C for SAE compatibility fluid RM-66-04 and various commercially available fluids (* indicates DOT 4 fluid).

reproduce the chemical changes observed during vehicle use, particularly the production of formic acid oxidation products.

OVERALL AGING: COMBINED PROCESSES - The best fit of lab-treated fluid composition to vehicle-aged fluids has been obtained if the volatilization step is performed after the air-sparged refluxing procedure previously described. A lower temperature is used for volatilization in this combined procedure because (1) fluid temperatures at the location of volatilization (reservoir or hose) will be lower than the maximum system temperature used for the thermal oxidation step and (2) volatilization at higher temperatures could cause changes in the relative concentrations of base fluid components which have not been observed in vehicles.

The 2 liters of previously refluxed fluid are degassed into a 4 liter beaker, which is then held, uncovered, at 80° C (thermocouple in the fluid 2.5 cm above the bottom) for 64 hours on a hotplate regulated by a temperature controller. The fluid is then cooled and filtered through 2.5 µm paper (Whatman 42) to remove suspended copper powder, taking care in pouring to capture any condensate on the sides of the beaker along with the liquid. Weight losses from the fluid during this volatilization step range from about 2 to 5%.

The black columns of Figure 3 show the %RA (vs. fresh fluid) retained after both the thermal oxidation and volatilization steps for a number of fluids. For most, but not all, fluids, almost all of the loss of buffering capacity occurs during the thermal oxidation step of the laboratory aging procedure.

Table 4 compares chemical parameters for fresh, laboratory-aged and vehicle-aged fluids. By design, the dissolved metals contents of lab-aged fluids are significantly lower than those of fluids used in vehicular service. The low metals contents in the lab-aged fluids simplify detection of corrosion when lab-aged fluid is put into the brake systems of new vehicles.

Table 4: Comparison of chemical properties of a fluid in vehicular-aged and laboratory-aged forms.

km	% RA	% amines	formamide % of amlin	Cu ppm	Fe ppm	Zn ppm
77371	17 %	5%	17%	220	110	50
83249	8%	3%	17%	210	80	80
77100	12 %	<3%	20%	320	160	120
lab-aged	13 %	8%	10%	82	3	<5

BEHAVIOR OF LABORATORY-AGED FLUIDS IN VEHICLES

DISSOLVED METALS - To test the correlation of expectations from laboratory work with true vehicular behavior, an experiment was run in matched new vehicles using two brake fluid formulations (I and II), each in both fresh and lab-aged conditions. Table 5 shows dissolved metals content after 6 months fluid use for the individual vehicles, grouped by fluid type. The clear difference between the four groups is that the lab-aged fluid I led to significantly higher dissolved iron levels than seen in the other three groups. Since repeat analysis confirmed an essentially null iron content for the lab-aged fluids at the time they were put into vehicles, it was clear that the laboratory-aged form of fluid I had initiated some form of iron corrosion during 6 months vehicular exposure. No iron corrosion was detected during this brief vehicular exposure for the non-aged form of I or for either the fresh or lab-aged forms of II. Comparison of the results of Table 5 with the new-fluid dissolved metals timeline of Figure 2 suggests that the laboratory aging procedure appears to have accelerated the relevant field about 30 months down the timeline. In contrast, fluid II showed no increase in 6 month vehicular dissolved iron after the same laboratory stress prior to installation in new matched vehicles, suggesting improved durability of iron corrosion protection.

CORROSION OF COMPONENTS - Figure 5 compares the interior surfaces of cast iron wheel cylinders which ran 6 months (top) and 12 months (bottom) with lab-aged fluids I (left) and II (right) in the vehicular experiment. The non-corroded appearance on the right duplicates all previous testing experience with fresh brake fluids - no corrosion of cast iron components occurs before several years of vehicular exposure. The rusting seen on the left with lab-aged I is similar to corrosion sometimes seen in wheel cylinders of vehicles after several years in the field - a patch of rust builds at the bottom of the cylinder. Electron microscopy of the rust patch shows, again in agreement with long-term vehicular experience, deposition of significant levels of copper in the corroded region. The appearance of this corrosion correlates with the elevated dissolved iron levels seen in laboratory-aged fluid I within 6 months of the start of service. No corrosion was seen in wheel cylinders running fresh fluids I or II or lab-aged fluid II, again in agreement with the dissolved iron data. It should be noted that the difference in dissolved Fe and observed cylinder corrosion was observed despite the similar levels of dissolved copper in all four groups of vehicles. While copper is implicated in the iron corrosion by its deposition in the rusted area, the data suggest that it is necessary to have severely depleted the iron corrosion inhibitors (amines) before the dissolved copper can accelerate the corrosion of iron.

Table 3: Dissolved metals for fresh and lab-aged fluids I and II, before and after 6 months service in matched vehicles.

Id	fresh / lab-aged	km	Cu ppm	Fe ppm	Zn ppm
I	fresh	0	0	0	0
II	fresh	0	0	0	0
I	aged	0	82	3	<3
II	aged	0	69	3	<3
I	fresh	16361	130	<3	11
I	fresh	30910	320	<3	27
I	fresh	18465	460	3	26
I	fresh	9746	150	<3	16
I	aged	35305	210	50	20
I	aged	11350	240	33	49
I	aged	24973	260	37	61
I	aged	20080	270	50	23
II	fresh	13584	110	2	12
II	fresh	26333	180	<3	16
II	fresh	7501	34	<3	5
II	fresh	34128	160	11	13
II	aged	17260	240	5	64
II	aged	19742	250	5	74
IV	aged	12613	250	3	42
II	aged	11779	360	3	61

BEHAVIOR OF LAB-AGED COMMERCIAL BRAKE FLUIDS IN SAE J1703 LABORATORY CORROSION TESTS

Internal corrosion of brake system components has been observed in some vehicles after several years' service in brake fluids which easily pass the corrosion tests in the J1703 standard. One cannot, therefore, have confidence that the standard corrosion tests performed on fresh fluids adequately predict the durability of corrosion protection for the life of the vehicle. Laboratory-aging of fluids prior to vehicle fill has reproduced long-term vehicular effects after much shorter vehicular exposure. In an attempt to develop a laboratory corrosion test which does have predictive power for the durability of corrosion protection, standard corrosion tests were run on a number of commercial brake fluids in both fresh and laboratory-aged (thermal oxidation + volatilization) conditions. In this application, the ca. 100 ppm copper level in some lab-aged fluids complicates the interpretation of weight-loss measurements. Copper deposition can accompany corrosion, (most noticeably on zinc, iron, and aluminum coupons) and decrease the magnitude (or even invert the apparent sign) of real corrosive weight losses. Lab-aged

fluids were therefore analyzed for metals after being used in corrosion test, and the dissolved metal contents were checked against the measured weight losses to ensure that the latter were not grossly misleading.

Table 4 shows standard J1703 corrosion test weight changes for SAE compatibility fluid RM-66-04 and for 9 commercially available fluids tested both in fresh and laboratory-aged conditions. A number of fluids showed significant zinc weight losses and/or etching when tested in lab-aged form. Otherwise no weight losses or gains outside the SAE limits were induced by lab-aging prior to the standard J1703 corrosion test. It should be noted that used fluid from vehicles can also show no objectionable weight losses in the standard J1703 corrosion tests, even when the used fluid is drawn from vehicles after service intervals which sometimes produce visible corrosion of components. It appears that the conditions of the corrosion test in J1703 are not severe enough to produce visible corrosion even from aged fluids which do allow visible internal brake system corrosion in severe vehicular service.

Table 7 shows preliminary results on weight changes for metals tested in lab-aged fluids by the J1703 method modified by addition of 50 ppm chloride to the test fluid. With the addition of chloride, not only zinc but also tin, iron, steel and/or aluminum showed pitting or etching with some lab-aged fluids.

Modifying the J1703 corrosion test both by lab-aged fluid and by addition of 50 ppm chloride clearly increases its severity and its ability to distinguish between fluids, at least in regards to coupon appearance. However, even this doubly-modified version of the SAE corrosion test does not reproduce the effect on cast iron observed in vehicles.

To minimize the future necessity of vehicular testing, even with lab-aged fluids, more stringent laboratory corrosion tests must be developed. Additional factors which may contribute to the more aggressive corrosion environment in vehicles compared to the standard J1703 corrosion test include details of the time-temperature history of the fluid and further changes in brake fluid chemistry induced by interactions with elastomers in the system (particularly hose materials). Further modifications to the standard J1703 corrosion test procedures, as applied to lab-aged fluids, are being investigated to determine the simplest possible laboratory corrosion test conditions which better reproduce the worst-case behavior of fluids in severe vehicular service.

SUMMARY AND CONCLUSIONS

Continually increasing expectations for durability of automotive components on the part of both consumers and manufacturers suggests the desirability of improved methods to ensure the durability of corrosion protection in brake fluids. Chemical analysis of used brake fluids has shown that the additives which are often the primary corrosion inhibitors can be lost over time both through thermal oxidation and by another process which completely removes nitrogen from the fluid. A two-step laboratory aging procedure was developed to reproduce these vehicular changes in brake fluid chemistry. Fluids subjected to this laboratory aging process typically still passed all of the corrosion weight change requirements of the standard SAE J1703 corrosion test (except, in some cases, that

for zinc). However, when lab-aged fluid was used in controlled vehicular tests of less than one year's duration, increased levels of dissolved iron appeared in the fluid and inspection of cast iron wheel cylinders showed visible internal corrosion. Such corrosion, with a morphology never before reproduced in laboratory or vehicular testing but seen in some vehicles after multiple years' actual service, suggests that the lab-aging procedure does reproduce corrosion properties representative of old fluid in severe service. Short-term vehicular testing with lab-aged fluid therefore provides the first feasible accelerated means of determining the long-term durability of both fluids and brake system components against internal corrosion.

J1703 corrosion test results with fresh, vehicle-aged, and laboratory-aged fluids show that the standard laboratory corrosion test procedures do not reproduce worst-case conditions, after long term vehicle use, even when the appropriate aged fluid chemistry is used. Appropriate additions of chloride increase the severity of the lab test conducted with lab aged fluids, but the fit to extreme vehicular conditions remains incomplete. Further development of laboratory corrosion tests, in conjunction with fluid-aging procedures, is needed if realistic, as well as reliable, prediction of the long-term corrosion durability of brake fluids and system components is to become possible.

ACKNOWLEDGMENTS

The authors owe thanks to many people for essential collaboration: W.A. Noll of Delphi Chassis contributed essential insights and support. M.S. Harrington, V. Gilliam, J. Larson, D. Lester, and D. Park of UCC performed analytical work and/or testing. T.E. Moylan of GM&RD performed much of the laboratory-aging work. K. L. Olson of GM&RD developed and ran the new NPD gas chromatographic and capillary electrophoresis techniques for analyzing brake fluid. T.J. Chapman, D.F. Esch, P.M. Hanley, and N.M. Power of GM&RD provided metals analysis and other analytical efforts.

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Figure 8: Cast iron wheel cylinders after 6 (top) and 12 (bottom) months vehicular service in lab-aged fluids I (left) and II (right).

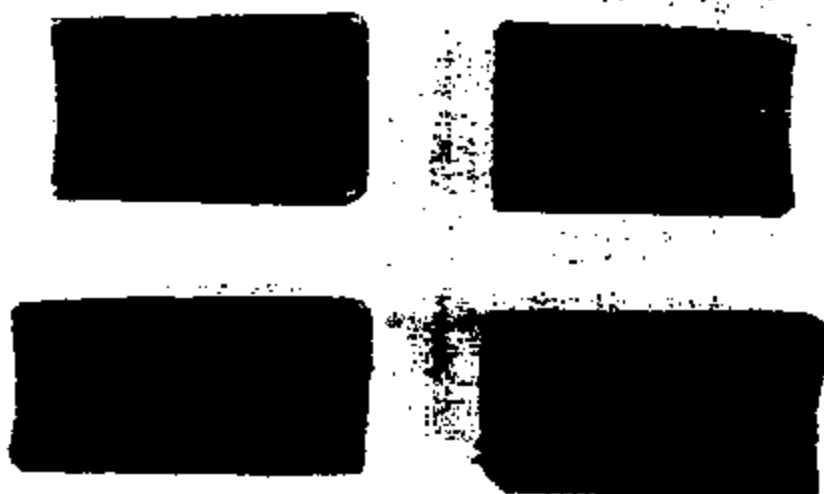


Table 6: J1703 weight changes for metals (mg/cm²) in fresh and lab-aged fluids (reported fresh/lab-aged). Results outside J1703 requirements established for fresh fluids printed in boldface (* indicates DOT 4 fluid).

Fluid	timed iron	steel	aluminum	cast iron	brass	copper	zinc
SAE max. allowed	±0.2	±0.2	±0.1	±0.2	±0.4	±0.4	±0.4
SAE	-0.00 /	-0.01 /	-0.00 /	+0.00 /	-0.02 /	-0.01 /	-0.02 /
RM-66-04	+0.04	+0.04	+0.04	+0.05	+0.02	+0.07	-0.32
a	-0.01 /	+0.01 /	-0.00 /	+0.04 /	-0.07 /	-0.06 /	-0.00 /
	+0.02	-0.00	-0.02	+0.00	-0.01	+0.02	-1.23
b	-0.01 /	-0.00 /	+0.03 /	+0.10 /	-0.02 /	+0.02 /	-0.33 /
	+0.04	+0.06	+0.02	+0.07	+0.24	+0.23	-3.04
c	+0.02 /	-0.01 /	+0.05 /	+0.00 /	-0.02 /	-0.04 /	-0.12 at /
	+0.01	+0.00	+0.04	+0.03	+0.07	+0.09	-3.00
d	+0.01 /	+0.03 /	+0.02 /	+0.03 /	-0.02 /	+0.01 /	+0.02 /
	+0.01	+0.02	+0.05	+0.06	-0.02	+0.01	+0.02
e	-0.00 /	-0.00 /	-0.01 /	-0.00 /	-0.07 /	-0.10 /	+0.02 /
	-0.01	+0.04	+0.05	+0.12	+0.09	+0.23	-1.81
f	+0.00 /	+0.03 /	+0.03 /	+0.04 /	-0.08 /	-0.06 /	+0.02 /
	+0.00	+0.04	+0.02	+0.03	-0.10	-0.00	-8.73 at
g	-0.01 /	+0.03 /	-0.00 /	+0.06 /	-0.03 /	-0.06 /	+0.01 /
	+0.03	+0.02	+0.02	+0.03	+0.05	+0.08	-0.32 at
h*	-0.00 /	-0.00 /	-0.00 /	+0.04 /	-0.00 /	+0.01 /	-0.03 /
	+0.03	+0.03	+0.01	+0.08	-0.03	+0.02	+0.04
j*	+0.06 /	+0.03 /	+0.03 /	+0.10 /	+0.02 /	+0.04 /	+0.12 /
	+0.01	+0.02	+0.01	+0.03	-0.14	-0.17	+0.07

at = etching (failure according to SAE J1703 requirement 4.6)

Table 7: Weight changes for metals (mg/cm²) in lab-aged fluids subjected to J1703 corrosion test procedure modified by addition of 50 ppm chloride to the test fluid. Results outside J1703 requirements (established for fresh fluids without chloride) printed in boldface (* indicates DOT 4 fluid).

fluid	tin/zinc iron	steel	aluminum	cast iron	brass	copper	zinc
SAE max. allowed	±0.2	±0.2	±0.1	±0.2	±0.4	±0.4	±0.4
SAE RM6-66-04	-0.00	+0.02	-0.00 at	+0.03	-0.04	+0.01	-0.04
a	+0.01	+0.02	+0.13 at	+0.06	-0.17	+0.21	-1.30
b	-0.01 pt	-0.04	-0.08	-0.00	+0.17	+0.23	-4.61 at
c	+0.03	+0.03	+0.02	+0.03	-0.02	+0.08	-1.34
d	-0.01	-0.06	+0.06 pt	-0.00	-0.13	-0.05	-0.61
e	-0.00	-0.03	+0.02 at	+0.04	-0.18	-0.05	-1.83 at
f	+0.02 pt	-0.00 pt	-0.02	+0.02	-0.01	+0.04	-1.42 at
g	+0.02	+0.03	-0.00 at	+0.10	-0.07	-0.00	-0.34 at
h*	-0.04 at	-0.01	-0.02	+0.04	-0.23	-0.13	+0.03
j*	-0.00 at	-0.00	+0.06 at	+0.06	-0.26	-0.20	+0.06

at = etching pt=ptite (failure according to SAE J1703 requirement 4.6)

Ticona**Performance
Polymers****Celanex® 4300**

Data Posted: 03/18/98

Polybutylene Terephthalate**Product Characteristics**

Appearance	Natural Color
Availability	North America
Features	Impact Resistance, Good
Filler/Reinforcement	Glass fiber reinforcement W 30 %
Material Status	Commercially Active
Processing Method	Injection Molding
Test Standards Reported	ASTM

Properties¹

Physical	Typical Values (Range)	Test
Specific Gravity	1.520	ASTM D792
Mold Shrink, Linear-Flow	3.000 to 5.000 mil/in	ASTM D696
Water Absorption @ 24 hrs	0.000.080 %	ASTM D570
Mechanical	Typical Values (Range)	Test
Coef. of Friction (vs. Metal - Static)	0.1750	ASTM D1894
Compressive Modulus	900000 psi	ASTM D696
Compressive Strength	20800 psi	ASTM D696
Flexural Modulus	1200000 psi	ASTM D790
Flexural Strength @ Yield	27000 psi	ASTM D790
Shear Strength	8100 psi	ASTM D732
Tensile Elongation @ Brk	2.7 %	ASTM D638
Tensile Modulus	1200000 psi	ASTM D638
Tensile Strength @ Break	18000 psi	ASTM D638
Impact	Typical Values (Range)	Test
Notched Izod Impact (73.0 °F)	1.90 ft-lb/in	ASTM D256
Tensile Impact Strength (73.0 °F)	54.00 ft-lb/in ²	ASTM D1622
Unnotched Izod Impact (73.0 °F)	9.30 ft-lb/in	ASTM D256
Hardness	Typical Values (Range)	Test

Rockwell Hardness (M-Scale)	D1	ASTM D785
Thermal	English	Test
CLTE, Flow	9.00E-08 in/in*F	ASTM D696
DTUL @ 284psi - Unannealed	389 °F	ASTM D848
DTUL @ 85psi - Unannealed	433 °F	ASTM D848
Electrical	English	Test
Arc Resistance (0.1200 in)	125.0 sec	ASTM D495
Dielectric Constant (100 Hz)	3.800	ASTM D150
Dielectric Strength	580.00 V/mil	ASTM D149
Dissipation Factor (100 Hz)	0.0020000	ASTM D150
Volume Resistivity	1.000E 16 ohm-cm	ASTM D257
Ignition Characteristics	English	Test
Flame Rating - UL (0.0312 in)	HB	UL 94
UL 746	English	Test
Comparative Track Index (0.1200 in)	500.0 V	UL 746
High Ampere Arc Ignition (0.1200 in)	99	UL 746
High Volt Arc Track Rate (0.1200 in)	0.50 in/min	UL 746
Hot Wire Ignition (0.1200 in)	63 sec	UL 746
Rel Temp Indx Elect (0.1200 in)	286 °F	UL 746
Rel Temp Indx Mech w/imp (0.1200 in)	286 °F	UL 746
Rel Temp Indx Mech w/outmp (0.1200 in)	284 °F	UL 746

Processing Information

Injection Molding Parameters	English	Test
Back Pressure	0 to 50 psi	
Drying Temperature	250 to 280 °F	
Drying Time	3.00 to 4.00 hr	
Front Temperature	470 °F	
Middle Temperature	460 °F	
Mold Temperature	160 to 200 °F	
Nozzle Temperature	480 °F	
Processing (Melt) Temp	450 to 500 °F	
Rear Temperature	480 °F	
Screw Compression Ratio	3.0:1.0 to 4.0:1.0	
Suggested Max Regrind	25.0 %	

1 Typical properties; not to be construed as specifications.

Performance Polymers © 1998

The information provided above is based on typical values. Typical values are intended only as guides and should not be used to establish specification limits or used alone as the basis of design. Performance Polymers assumes no obligations or liability for any advice furnished or for any results obtained with respect to this information. The determination of the suitability of the above information for any particular use is solely the responsibility of the user.

Ticona**Performance
Polymers****Celanex® 3316**

Data Posted: 03/18/06

Polybutylene Terephthalate**Product Characteristics**

Availability	North America
Features	Flame Retardant Processability, Good
Filler/Reinforcement	Glass fiber reinforcement W 30 %
Forms	Pellets
Material Status	Commercial: Active
Processing Method	Injection Molding
Test Standards Reported	ASTM

Properties¹

Physical	Typical Value	Test
Specific Gravity	1.690	ASTM D792
Mechanical	Typical Value	Test
Flexural Modulus	1400000 psi	ASTM D790
Flexural Strength @ Yield	29500 psi	ASTM D790
Tensile Elongation @ Brk	2.6 %	ASTM D638
Tensile Strength @ Break	19900 psi	ASTM D638
Impact	Typical Value	Test
Notched Izod Impact (73.0 °F)	1.40 ft-lb/in	ASTM D256
Unnotched Izod Impact	13.00 ft-lb/in	ASTM D256
Thermal	Typical Value	Test
DTUL @ 254psi - Unannealed	403 °F	ASTM D648
DTUL @ 66psi - Unannealed	430 °F	ASTM D648
Electrical	Typical Value	Test
Arc Resistance (0.0312 in)	108.0 sec	ASTM D405
Dielectric Constant (1000 Hz)	3.700	ASTM D189
(1000000 Hz)	3.500	
Dielectric Strength	575.00 V/mil	ASTM D149
Volume Resistivity	1.800E 18 ohm-cm	ASTM D257
Ignition Characteristics	Typical Value	Test
Flame Rating - UL (0.0312 in)	V-0	UL 94
UL 746	Typical Value	Test
Comparative Track Index (0.0312 in)	250.0 V	UL 746

Processing Information

Injection Molding Parameters	Typical Value	Test
Back Pressure	0 to 50 psi	
Drying Temperature	280 to 290 °F	
Drying Time	3.00 to 4.00 hr	
Front Temperature	470 °F	
Middle Temperature	460 °F	
Mold Temperature	160 to 200 °F	
Nozzle Temperature	480 °F	
Processing (Melt) Temp	480 to 500 °F	
Rear Temperature	480 °F	

¹ Typical properties; not to be construed as specifications.

Performance Polymers © 1999

The information provided above is based on typical values. Typical values are intended only as guides and should not be used to establish specification limits or used alone as the basis of design. Performance Polymers assumes no obligations or liability for any advice furnished or for any results obtained with respect to this information. The determination of the suitability of the above information for any particular use is solely the responsibility of the user.

UL94V-0, V-1, V-2

Specimens

3" x 1/8" x thickness
(typically thickness is 1/16", 1/8", 1/4")

Procedure

Total of 10 specimens (2 sets) are tested per thickness.

Five of each thickness are tested after conditioning 48 hours at 23°C and 50% RH.

Five of each thickness are tested after conditioning for 7 days at 70°C.

Specimen is mounted with long axis vertical. Specimen is supported such that its lower end is 3/8" above Bunsen burner tube. Blue 3/4" high flame is applied to the corner of the lower edge of specimen for 10 seconds. If burning ceases within 30 seconds, flame is re-applied for an additional 10 seconds.

If specimen drips particles, these shall be allowed to fall onto a layer of unaged surgical cotton placed 12" below the specimen.

Classification Requirements

For 94V-0

- Not have any specimens that burn with flaming combustion for more than 10 seconds after either application of the test flame.
- Not have a total flaming combustion time exceeding 50 seconds for the 10 flame applications for each set of 5 specimens.
- Not have any specimens that burn with flaming or glowing combustion up to the holding clamp.
- Not have any specimens that drip flaming particles that ignite the dry absorbent surgical cotton located 12" below the test specimen.
- Not have any specimens with glowing combustion that persists for more than 30 seconds after the second removal of the test flame.

For 94V-1

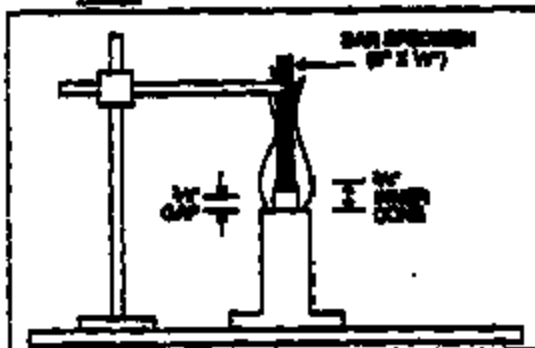
- Not have any specimens that burn with flaming combustion for more than 30 seconds after either application of the test flame.
- Not have a total flaming combustion time exceeding 250 seconds for the 10 flame applications for each set of 5 specimens.
- Not have any specimens that burn with

flaming or glowing combustion up to the holding clamp.

- Not have any specimens that drip flaming particles that ignite the dry absorbent surgical cotton located 12" below the test specimen.
- Not have any specimens with glowing combustion that persists for more than 60 seconds after the second removal of the test flame.

For 94V-2

- Not have any specimens that burn with flaming combustion for more than 30 seconds after either application of the test flame.
- Not have a total flaming combustion time exceeding 250 seconds for the 10 flame applications for each set of 5 specimens.
- Not have any specimens that burn with flaming or glowing combustion up to the holding clamp.
- Be permitted to have specimens that drip flaming particles that burn only briefly, some of which ignite the dry absorbent surgical cotton placed 12" below the test specimen.
- Not have any specimens with glowing combustion that persists for more than 60 seconds after the second removal of the test flame.



UL94 Flammability Test V-0, V-1, V-2

Vertical Flame Class Requirements			
	94V-0	94V-1	94V-2
Individual Flame Time, seconds	≤ 10	≤ 30	≤ 30
Total Flame Time, seconds (5 specimens)	≤ 50	≤ 250	≤ 250
Glowing Time, seconds (individual specimens)	≤ 10	≤ 30	≤ 30
Drip Particle Test, Ignites	NO	NO	YES

UL Performance Level Classes (PLC)

In order to avoid an excessive level of implied precision and bias, material performance from several tests are recorded as Performance Level Classes (PLC), based on the mean test results (rather than recording the exact numerical results), as indicated in the tables following the test descriptions.

HWI (hot wire ignition)

HWI Range— Mean Ignition Time (s) in seconds	Assigned PLC
100 and longer	0
80 and up to 100	1
50 and up to 80	2
20 and up to 50	3
7 and up to 20	4
Less than 7	5

Table A

Hot-wire ignition (HWI) performance is expressed as the mean number of seconds needed to either ignite standard specimens or to burn through the specimens without ignition. Ten specimens are wrapped with resistance wire that dissipates a specified level of electrical energy.

HAI (high amp arc ignition)

HAI Range— Mean Number of Arcs to Cause Ignition (60s)	Assigned PLC
100 and greater	0
50 and up to 100	1
20 and up to 50	2
10 and up to 20	3
Less than 10	4

Table B

High amp arc ignition (HAI) performance is expressed as the number of arc exposure exposures (numbered as to electrode type and shape and electric circuit) which are necessary to ignite a material when they are applied at a standard rate, either on the surface of the material or at a specified distance from it.

HVTR (high voltage arc tracking rate)

HVTR Range— (TR in sec/min)	Assigned PLC
0 through 25	0
Over 25 through 50	1
Over 50 through 75	2
Over 75 through 100	3
Over 100	4

Table C

High voltage arc tracking rate (HVTR) is depicted as the rate, in seconds, that a tracking path can be produced on the surface of the material under standard test conditions. Note is made if ignition of the material takes place. The results of testing the nominal 1/8" (3mm) thickness are considered representative of the material's performance in any thickness.

D495 (ASTM D495 arc resistance)

D495 Range— Mean Time of Arc Resistance (30s in seconds)	Assigned PLC
400 and longer	0
300 and up to 400	1
200 and up to 300	2
100 and up to 200	3
50 and up to 100	4
20 and up to 50	5
01 and up to 20	6
Less than 01	7

Table D

Arc resistance (D495) is accordance with ASTM D495 is expressed as the number of seconds that a material resists the formation of a surface conducting path when subjected to an low-frequency alternating arc of high voltage, low current characteristics. The results of testing the nominal 1/8" (3mm) thickness are considered representative of the material's performance in any thickness.

CTI (comparative tracking index)

CTI Range— Tracking Index (50V value)	Assigned PLC
600 and greater	0
400 and up to 600	1
200 and up to 400	2
100 and up to 200	3
50 and up to 100	4
Less than 50	5

Table E

Comparative tracking index (CTI) is expressed as that voltage which causes tracking on a material after 30 drops of 1% ammonium chloride solution has fallen. The results of testing the nominal 1/8" (3mm) thickness are considered representative of the material's performance in any thickness.

RTI (relative thermal index)

Materials are investigated with respect to retention of certain critical properties (e.g., dielectric, flameability, tensile impact, and the like) as part of a long-time thermal-aging program conducted in accordance with Underwriters Laboratories, Inc. Standard for Polymeric Materials -- Long Term Property Retention (UL 746). The end-of-life of a material at each test temperature in this program has been assumed to be the time when the value of the critical property has decreased to 50% of its original (as received) value. The temperature index shown in the individual Recognitions correlates numerically with the temperature in °C above which the material is likely to degrade prematurely when based on a comparison with similar results of a material which has had acceptable service experience. More than one relative thermal index may be appropriate for a given material depending on the property requirements for a given application.

COMMUNICATIONS

Name / Project Mike Kitt
 Company / Department DOW
 Address Plaquemine LA

Phone 225-353-6343 FAX 1-800-425-7266

DATE 3/10/97 TIME NOON

STATUS OF 5 GALS OF BRAKE FLUID w/o INHIBITOR? NEED PLANT DATE? Mike will expedite.

✓ EMAIL Shipping address and contact

CONDUCTIVITY OF BRAKE FLUID? WILL GET CONDUCTIVITY DATA w/o INHIBITOR and for new fluid

No field data found in search for physical properties

SAE-921007, DOW MADE ANY LAB-AGED? No DOW has not done it

Sent Greg Stevens 1998 test data on corrosion

Dow says 2 other SAE research was not conclusively successful.

**Brake Pressure Switch
F2YC-SF324-AB
Material List for MY 92/93**

Component Name	Material	Comments
Gasket	Elastomer Ethylene Propylene	JEL Compound # E-7104-70
Diaphragm	Kapton, Polyimide	Dupont 500 FN131L, 3 Diaphragms per switch
Base	PBT, Plastic	Grade Celanex 4300
Crimp Ring	Aluminum	Grade # 5052
Spacer	Kapton, Polyimide	Dupont #200H, Friction Reducer on Disc
Rivet	Brass	CDA 280
Transfer Pin	Ceramic	Steele, L-3 Grade
Environmental Seal	Silicone	JEL Compound # S7519
Converter	Cold Rolled Steel	Grade # 1008
Washer	Cold Rolled Steel, Zinc Plated	Grade # 1050
Cup	Cold Rolled Steel	Grade 1010
Spring Arm	Beryllium Copper	Grade # C17200
Movable Contact	Silver Plated Copper	Oxygen Free Cu, Fine Silver
Stationary Terminal	Brass + Silver Inlay	CDA 280
Movable Terminal	Brass	CDA 280
Disc	Stainless Steel	Grade 302
Hexport	Cold Rolled Steel, Zinc Plated	C10L10
Thread Cap	LDPE, Plastic	

MAR- 1-95 WED 10:20

TI HOLDING ATTLE

FAX NO. 5088893141

P.01

FLAM DATA

TABLE IV
CELANEX 4000 SERIES, TYPICAL PROPERTIES
ENGLISH UNITS

Property	ASTM Test Method	Units	4380	4390
SPECIFIC GRAVITY	D792	—	1.03	1.03
WATER ABSORPTION	D670	—	—	—
24 HOUR IMMERSION	—	%	0.08	0.10
MOLD SHREDDAGE, FLOW DIRECTION, 1/8" THICKNESS	—	in/in x 10 ⁻³	3.0	2.5-4.5
MECHANICAL @ 73°F	—	—	—	—
TENSILE STRENGTH @ BREAK	D638	psi	18,000	14,000
TENSILE MODULUS	D638	10 ³ psi	1.2	1.2
ELONGATION @ BREAK	D638	%	2.1	3.1
FLEXURAL STRENGTH	D790	psi	27,200	22,000
FLEXURAL MODULUS	D790	10 ³ psi	1.3	1.3
COMPRESSIVE STRENGTH	D695	psi	20,800	—
COMPRESSIVE MODULUS	D695	10 ³ psi	0.9	—
SHEAR STRENGTH	D732	psi	5,100	5,400
1000 IMPACT STRENGTH	D336	—	—	—
NOTCHED	—	ft-lb/in	1.9	3.0
UNNOTCHED	—	ft-lb/in	9.3	12
TENSILE IMPACT STRENGTH	D1632	ft-lb/in ²	54	66
TABER ABRASION	D1044	mg/1000 cycles	39	42
ROCKWELL HARDNESS	D798	M Scale	51	50
COEFFICIENT OF FRICTION AGAINST METALS	—	—	—	—
DYNAMIC	—	—	0.13-0.15	0.18-0.25
STATIC	—	—	0.17-0.18	0.18-0.22
THERMAL	—	—	—	—
HEAT DEFLECTION TEMPERATURE	D646	°F	430	424
30 psi	—	°F	388	376
164 psi	—	—	—	—
COEFFICIENT OF LINEAR THERMAL EXPANSION	D696	in/in°F x 10 ⁻³	0.9	0.9
TEMPERATURE RANGE: 22°F to 234°F	—	—	—	—
FLOW DIRECTION	—	—	—	—
DEFORMATION UNDER LOAD	—	—	—	—
AT 122°F, 24 HOURS	D621	%	0.2	1.25
2000 psi	—	%	0.6	4.31
4250 psi	—	—	—	—
ELECTRICAL	—	—	—	—
VOLUME RESISTIVITY	D257	ohm-cm	10 ¹⁰	4 x 10 ¹⁰
DIELECTRIC STRENGTH	D149	volts/mil	680	800
SHORT TERM, 1/8" THICKNESS	—	—	—	—
73°F, 50% RH	—	—	670	880
73°F, 95% RH	—	—	570	480
73°F, 6 WEEKS IN 73°F WATER	—	—	590	570
150°F, 95% RH	—	—	540	600
250°F, 50% RH	—	—	3.9	4.5
DIELECTRIC CONSTANT, 100 Hz	D190	—	0.002	0.004
DISSIPATION FACTOR, 100 Hz	D190	—	—	—

4000 SERIES UNDERWRITERS LABORATORIES RATINGS

Rating of Property*	Units	4380	4390
TEMPERATURE INDICES	—	—	—
ELECTRICAL	°C	120	120
MECHANICAL W/IMPACT	°C	120	120
MECHANICAL W/O IMPACT	°C	140	140
ARC RESISTANCE	seconds	180	125
COMPARATIVE TRACKING INDEX	volts	600	600
HOT WIRE IGNITION	seconds	93	121
HIGH AMP ARC IGNITION	area	95	33
HIGH VOLTAGE TRACK RATE	in/min	0.5	0.5
FLAMMABILITY @ 122°F UL94	—	HB	HB
COLOR RETENTION	—	AN	AN

*At 0.125" thickness except where noted.

FEB 18 '99 10:48 PM FORD DAE DEARBORN MI 313 337 8286 TO 83286

P.01/03

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PC4

September 25, 1991

To: Donna Neynihan 12-27

From: Beth Kill 10-16

Subject: Material Confirmation
TSL Request # 110822

Sample Description:

P/N 74176-1 Seal Teflon and Kapton

Results:

DSC results confirm the presence of Teflon by the characteristic melt point at 316 - 319 degrees C.

Kapton is confirmed in the seal by the IR scan. It shows the same characteristic absorbances exhibited by the sample known to be Kapton. See the enclosed scan.

Finally, the Teflon is confirmed to be on the surface of both sides of the seal by EDAX analysis.

Regards,

Beth X3069

Form # Fax Note	7571	Date	2-18-99	Page	3
To	JOHN REIMERS	From	H.R. LABORTE		
Co/Dept		Co.	DAE. Int'l.		
Phone #	X03286	Phone #	43686		
Fax #	X39-03286	Fax #			

August 28, 1991

To: Donna Moynihan 12-27

From: Beth Kill 10-16

Subject: GP-3 Material Confirmation
TEL Request # 110822

Sample Description:

P/N 46515-2 Thermoplastic Polyester
Celanex 4300

Results:

	P/N 46515-2	Spec.
Glass Fill	32%	30%

TGA results confirm the base contains slightly high glass fill. DSC results confirm the base material to be a thermoplastic polyester with a melting point at 223 - 225 deg. C., and a glass transition at 50 - 60 deg. C., consistent with Celanex 4300.

Regards,

Beth X3069



Texas Instruments Incorporated

24 Fawcett Street
P.O. Box 2994
Austin, TX 78768-0994
(502) 238-1800

JANET S. BOURGEOIS**Ph : 508-236-3287****Fax : 508-236-1888**

Conder
McGILLIC

To : Fred Potter

Re :

Total # Pages = 6

Message : _____

Thanks,
Janet S. Bourgeois

3713 2080

References

PRODUCT DATA SHEET

Product Support
General Electric Company
 One Pacific Avenue, Fairfield, NJ 07004
 800 645-6888, Fax 201 646-5773

PAGE 1

主 題 詞 目 號 007:10

UL MATERIAL PROPERTIES REPORT
ON PLASTICS
AGENCY SERVICES

PRODUCT F FILM: MORYL
UL REFERS CE FILM: E12166E E-19

PRICES LISTED ON THIS PAGE APPLY TO ALL ORDERS OF MONYL
LISTED BELOW:

DTX030

COLOR	TICK- PES (MM)	FLAME CLASS	RTX			HMX	HAI GE/AS	HVTW	DAPS	CTE
			ELEC	M/IMP	M/O IMP					
BLACK	1.27 mm	HB	ED	ED	ED	0	3	1	M/A	-
	1.14 mm	HB	ED	ED	ED	0	2	1	4	2

FOOTNOTES

STAN' AND GM-PLASTICS MATERIAL DISCLAIMER APPLIES

Tolson 3/4/99

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There can be growth on the outside and the inside of the dollar and the economy, it could rise and stabilize for its own sake," says Chynoweth. "Rising dollar."

[illegible]

3713 2081

Procedure For Obtaining UL Listing Of Device

- Manufacturer opens an assignment
Describes device
Requests review and application forms
- UL response
Identifies device standard
Outlines test program
Provides cost limits and forms
- Manufacturer submits samples and forms
- Samples tested by UL
- If results acceptable
Device is listed
Manufacturer can attach UL label
Follow-up procedure is established
- If results unacceptable
Corrections must be made
Re-submitted and re-tested

UL94 Standard Test Procedures And Requirements

UL94HB

Specimens

5" x 1/2" x thickness
(typically thickness is 1/16", 1/8", 1/4")

Procedure

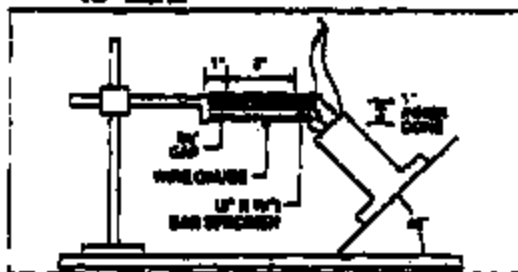
Three specimens are tested per thickness after conditioning for 48 hours at 23°C and 50% RH. Specimen is mounted with its long axis horizontal and its short axis at a 45° angle. Each specimen is marked with two lines, 1" and 4" from one end of specimen.

Specimen is supported at one end such that its lower edge is 1/8" above a plate of wire gauze. A 1" high blue Bunsen burner flame is applied to the free end of the specimen for 30 seconds and then removed. If the specimen continues to burn after removal of the test flame, the time for the flame front to travel between the two gauge marks is measured and the burning rate calculated in inches per minute.

Classification Requirements

For 94HB

- A. Not have a burning rate exceeding 1.5" per minute over a 30" span for specimens having a thickness of 0.120" to 0.500", or
- B. Not having a burning rate exceeding 3.0" per minute over 50" span for specimens having a thickness less than 0.120", or
- C. Cease to burn before the flame reaches the 40" mark.



Horizontal Burning Test for 94HB Classification

94HB Horizontal Flame Class Requirements	
Thickness	Burning Rate
≥ 1/16 in.	≤ 1 1/2 in/min.
< 1/16 in.	≤ 3 in/min.

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GEP PROD SUPPORT

UL Performance Level Classes (PLC)

In order to avoid an excessive level of implied precision and bias, material performance from several tests are recorded as Performance Level Classes (PLC), based on the mean test results (rather than recording the exact numerical results), as indicated in the tables following the test descriptions.

HWI (hot wire ignition)

HWI Range — Mean Ignition Time (IT) in seconds	Assigned PLC
120 and greater	0
90 and up to 120	1
60 and up to 90	2
30 and up to 60	3
7 and up to 30	4
Less than 7	5

Table A

Hot-wire ignition (HWI) performance is expressed as the mean number of seconds needed to either ignite standard specimens or to burn through the specimen without ignition. Test specimens are wrapped with resistance wire that dissipates a specified level of electrical energy.

HAI (high amp arc ignition)

HAI Range — Mean Number of Arcs to Cause Ignition (NAI)	Assigned PLC
120 and greater	0
90 and up to 120	1
60 and up to 90	2
30 and up to 60	3
Less than 30	4

Table B

High amp arc ignition (HAI) performance is expressed as the number of arc rupture exposures (standardized as to electrode type and shape and electric circuit) which are necessary to ignite a material when they are applied at a standard rate, either on the surface of the material or at a specified distance from it.

HVTR (high voltage arc tracking rate)

HVTR Range — (TR in mm/min.)	Assigned PLC
0 through 11	0
Over 11 through 25	1
Over 25 through 50	2
Over 50 through 100	3
Over 100	4

Table C

High voltage arc tracking rate (HVTR) is denoted as the rate, in mm/min., that a tracking path can be produced on the surface of the material under standardized test conditions. Note is made if ignition of the material takes place. The results of testing the nominal 1/8" (3mm) thickness are considered representative of the material's performance in any thickness.

D495 (ASTM D495 arc resistance)

D495 Range — Mean Time of Arc Resistance (TAR in seconds)	Assigned PLC
400 and longer	0
300 and up to 400	1
200 and up to 300	2
100 and up to 200	3
50 and up to 100	4
20 and up to 50	5
Less than 20	6

Table D

Arc resistance (D495) in accordance with ASTM D495 is expressed as the number of seconds that a material resists the formation of a surface conducting path when subjected to an increasingly occurring arc of high voltage, low current characteristics. The results of testing the nominal 1/8" (3mm) thickness are considered representative of the material's performance in any thickness.

CTI (comparative tracking index)

CTI Range — Tracking Index (TI) in volts	Assigned PLC
600 and greater	0
400 and up to 600	1
250 and up to 400	2
175 and up to 250	3
100 and up to 175	4
Less than 100	5

Table E

Comparative tracking index (CTI) is expressed as that voltage which causes tracking on a material after 60 drops of 0.1% ammonium chloride solution has fallen. The results of testing the nominal 1/8" (3mm) thickness are considered representative of the material's performance in any thickness.

RTI (relative thermal index)

Materials are investigated with respect to selection of certain critical properties (e.g., dielectric, flammability, tensile impact, and the like) as part of a long-time thermal-aging program conducted in accordance with Underwriters Laboratories, Inc. Standard for Polymeric Materials — Long Term Property Evaluations (UL746B).

The end-of-life of a material at each test temperature in this program has been assumed to be the time when the value of the critical property has decreased to 50% of its original (as received) value. The temperature index shown in the individual Recognitions correlates numerically with the temperature in °C above which the material is likely to degrade prematurely when based on a comparison with similar results of a material which has had acceptable service experience. More than one relative thermal index may be appropriate for a given material depending on the property requirements for a given application.

UL94-5VA Or UL94-5VB

Material shall be classified 94-5VA or 94-5VB on the basis of test results obtained on small bar and plaque specimens. Test procedures are as follows:
Specimens that do not exhibit a burn through (hole) are classified 94-5VA.

Specimens that burn through (hole) are classified 94-5VB.

Specimens:

- 8" x 1/2" x thickness (bars)
- 8" x 8" x thickness (plaques)
- (typically thickness is 1/16", 1/8", 1/4")

Procedure for Bar Specimen (Method A):

Total of 10 specimens (2 sets) are tested per thickness.

Five of each thickness are tested after conditioning 48 hours at 23°C and 50% R.H.

Five of each thickness are tested after conditioning 7 days at 70°C.

For bar specimens, specimen is mounted with its long axis vertical.

A 5" overall high Bunsen burner flame with a 1 1/2" blue inner cone is applied to a lower corner of the specimen at an angle of 25° from the vertical such that the tip of the blue cone touches the specimen.

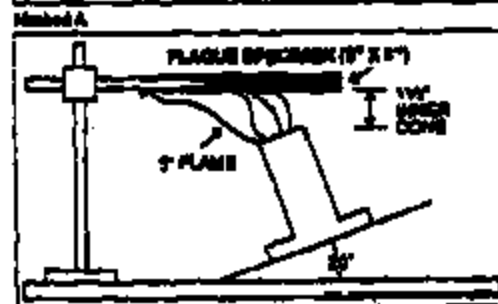
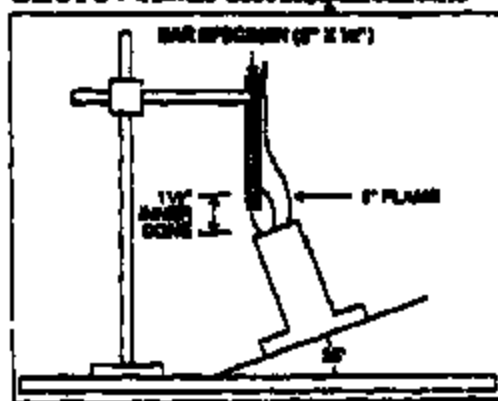
The flame is to be applied for 5 seconds and removed for 5 seconds. The operation is to be repeated until the specimen has been subjected to 5 applications of the test flame.

Classification Requirements:

- A. Not have any specimens that burn with flaming or glowing combustion for more than 60 seconds after the fifth flame.
- B. Not have any specimens that drip flaming particles that ignite dry absorbent surgical cotton located 12" below the specimen.

Procedure for Plaque Specimen (Method B):

Same as for bars except that 2 plaques (2 sets) are to be mounted in the horizontal plane with the flame applied to the center of the bottom surface of the plaque.

UL 94-5V Flame Test Requirements

UL 94-5V Flame Test Requirements	
Maximum Flame Time, seconds	60
Maximum Glow Time, seconds	60
Drip Particle Test Ignite	NO

Summary Of UL Listings For GE Materials

GE engineering plastics are listed under the "Plastics" section in the Underwriters Laboratories, Inc. Recognized Component Directory. This means that these materials have been evaluated in respect to ignition and flammability characteristics and certain other "as molded" properties, as well as in respect to effects of certain environmental conditions (e.g., heat aging).

Pages 8 through 37 contain data on GE plastics appearing in the UL Component Directory.

UL94V-0, V-1, V-2**Specimen:**

5" x 1 1/2" x thickness
(typically thickness is 1/16", 1/8", 1/4")

Procedure:

Total of 10 specimens (2 sets) are tested per thickness.

Five of each thickness are tested after conditioning 48 hours at 23°C and 50% RH.

Five of each thickness are tested after conditioning for 7 days at 70°C.

Specimen is mounted with long axis vertical. Specimen is supported such that its lower end is 2 1/2" above burner burner tube. Blue 2 1/4" high flame is applied to the center of the lower edge of specimen for 15 seconds. If burning ceases within 30 seconds flame is re-applied for an additional 10 seconds.

If specimen drips particles, these shall be allowed to fall onto a layer of ungreased surgical cotton placed 12" below the specimen.

Classification Requirements**For 94V-0**

- Not have any specimens that burn with flaming combustion for more than 10 seconds after either application of the test flame.
- Not have a total flaming combustion time exceeding 50 seconds for the 10 flame applications for each set of 5 specimens.
- Not have any specimens that burn with flaming or glowing combustion up to the holding clamp.
- Not have any specimens that drip flaming particles that ignite the dry absorbent surgical cotton located 12" below the test specimen.
- Not have any specimens with glowing combustion that persists for more than 30 seconds after the second removal of the test flame.

For 94V-1

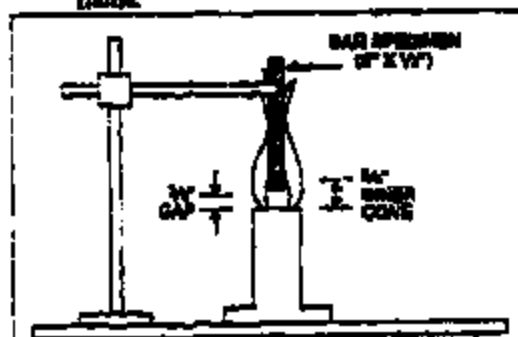
- Not have any specimens that burn with flaming combustion for more than 50 seconds after either application of the test flame.
- Not have a total flaming combustion time exceeding 250 seconds for the 10 flame applications for each set of 5 specimens.
- Not have any specimens that burn with

flaming or glowing combustion up to the holding clamp.

- Not have any specimens that drip flaming particles that ignite the dry absorbent surgical cotton located 12" below the test specimen.
- Not have any specimens with glowing combustion that persists for more than 60 seconds after the second removal of the test flame.

For 94V-2

- Not have any specimens that burn with flaming combustion for more than 30 seconds after either application of the test flame.
- Not have a total flaming combustion time exceeding 250 seconds for the 10 flame applications for each set of 5 specimens.
- Not have any specimens that burn with flaming or glowing combustion up to the holding clamp.
- Be permitted to have specimens that drip flaming particles that burn only briefly, some of which ignite the dry absorbent surgical cotton placed 12" below the test specimen.
- Not have any specimens with glowing combustion that persists for more than 60 seconds after the second removal of the test flame.



UL94 Flammability Test V-0, V-1, V-2

	Vertical Flame Class Requirements		
	94V-0	94V-1	94V-2
Individual Flame Time, seconds	≤ 10	≤ 60	≤ 30
Total Flame Time, seconds (Specimens)	≤ 50	≤ 250	≤ 250
Glowing Time, Seconds (Individual specimens)	≤ 10	≤ 30	≤ 60
Drip Particles That Ignite	NO	NO	YES

Summary of Chemical Properties
3/2/99

The following pages were supplied by Dupont and show chemical and physical properties for Teflon and Kapton. In summary, water will degrade the mechanical properties of Kapton, but Teflon is unaffected by water. This is the reason why the Teflon-Kapton-Teflon system was selected for Texas Instruments switch diaphragm (3 mil thick Kapton layer coated with 1 mil Teflon on both sides). Page 1 (marked with "A") indicates that the Teflon is non-reactive with water. While page 2 shows Teflon has a relatively low vapor transmission rate (marked with "B"). Page 3 shows how the mechanical properties of Kapton degrade with water and temperature exposure (marked with "C").

End of document.

Chemical Properties

DuPont FEP fluorocarbon film is chemically inert and solvent resistant to virtually all chemicals except molten alkali metals, fluorine at elevated temperatures, and certain complex halogenated compounds such as chlorine trifluoride at elevated temperatures and pressures.

In circumstances where end-use temperatures are close to the upper service limit 205°C (400°F), 20% sodium hydride, metal hydrides, aluminum chloride, azobenzene, and certain amines (R-NH₂) may attack the film in a manner similar to molten alkali metals. Special testing is required when such extreme reducing or oxidizing conditions are evident.

With these exceptions noted, DuPont FEP fluorocarbon films exhibit a very broad range of chemical and thermal serviceability.

Due to the many complex aspects of performance in severe environments, final selection should be based on functional evaluations or extensive end-use conditions.

The chemical substances listed in Table 1 are representative of those with which DuPont FEP film has been found to be nonreactive.

TEFLON

Table 1
Typical Chemicals with Which DuPont FEP Film is Nonreactive*

Acetic acid	Cyclohexanone	Hydrofluoric acid	Peracetic acid
Acetic anhydride	Dibutyl phthalates	Hydrogen peroxide	Picric acid
Acetone	Dibutyl sebacate	Lead	Pipridene
Acetophenone	Dibutyl carbonate	Magnesium chloride	Polystyrene
Acrylic anhydride	Dibutyl ether	Mercury	Potassium acetate
Allyl acetate	Dimethyl formamide	Methyl ethyl ketone	Potassium hydroxide
Allyl methacrylate	Diisobutyl adipate	Methacrylic acid	Potassium permanganate
Aluminum chloride	Dimethylformamide	Methanol	Pyridine
Ammmonia, liquid	Dimethylhydrazine, unsymmetrical	Methyl methacrylate	Sand and detergents
Ammonium chloride	Dioxane	Naphthalene	Selenium dioxide
Aniline	Ethyl acetate	Naphthalene	Selenium hypochlorite
Benzonitrile	Ethyl alcohol	Nitric acid	Selenic peroxide
Benzoyl chloride	Ethyl ether	Nitrobenzene	Selenic acid, selenic acid and selenic acid
Benzyl alcohol	Ethyl hexanoate	Nitromethane	Stannous chloride
Borax	Ethylene bromide	Nitrogen tetroxide	Sulfur
Boric acid	Ethylene glycol	2-Nitro-2-methyl propanol	Sulfuric acid
Bromine	Ferric chloride	n-Octadecyl alcohol	Tetralin
n-Butyl amine	Ferric phosphate	Oil, animal and vegetable	Tetrachloroethylene
Butyl acetate	Fluoronaphthalene	Ozone	Trichloroacetic acid
Butyl methacrylate	Fluoromethoxybenzene	Perchloroethylene	Trichloroethylene
Calcium chloride	Formaldehyde	Pentachlorobenzamide	Trichlorophosphate
Carbon disulfide	Formic acid	Perfluorobenzene	Trichloroamine
Cetane	Furane	Phenol	Vinyl methacrylate
Chloroform	Gasoline	Phosphoric acid	Water
Chlorosulfonic acid	Hexachlorocyclopentadiene	Phosphorus pentachloride	Xylene
Chromic acid	Hexane		Zinc chloride
Cyclohexane	Hydrazine		
	Hydrochloric acid		

*Based on experiments conducted up to the boiling points of the liquids listed. FEP resins have normal service temperatures up to 205°C (400°F). Absence of a specific chemical does not mean that it is reactive with FEP film.

**Some halogenated solvents may cause moderate swelling.

① BRAKE FLUID BASE ?

TEFLON FEP

Physical Properties

Absorption

Almost all plastics absorb small quantities of certain materials with which they come in contact. Submicroscopic voids between polymer molecules provide space for the material absorbed without chemical reaction. This phenomenon is usually marked by a slight weight increase and sometimes by discoloration.

DuPont FEP fluorocarbon films have unusually low absorption compared with other thermoplastics. They absorb practically no common acids or bases at temperatures as high as 200°C (392°F) and exposures of up to one year. Even the absorption of solvents is extremely small. Weight increases are generally less than 1% when exposed at elevated temperatures for long periods. In general, aqueous solutions are absorbed very little by DuPont FEP film. Moisture absorption is typically less than 0.01% at ambient temperature and pressure.

Permeability

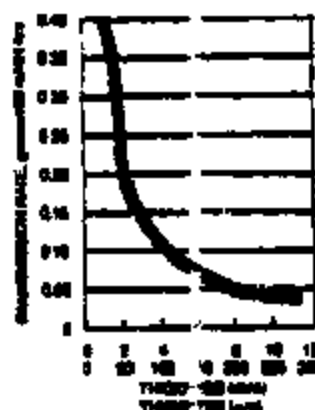
Many gases and vapors permeate FEP films at a much lower rate than for other thermoplastics (see Figure 13). In general, permeation increases with temperature, pressure, and surface contact area and decreases with increased film thickness. Table 6 lists rates at which various gases are transmitted through DuPont FEP fluorocarbon film, while Table 7 lists rates of vapor permeability for some representative substances. Note that the pressure for each material is its vapor pressure at the indicated temperature.

Table 6
Typical Gas Permeability Rates of DuPont FEP Fluorocarbon Film, 25 μ m (1 mil) Thickness
(Test Method: ASTM D-1488 at 25°C (77°F))

Gas	Permeability Rate (cm ³ /m ² ·s·atm)
Carbon Dioxide	25.0 × 10 ⁻¹⁰
Hydrogen	34.1 × 10 ⁻¹⁰
Nitrogen	6.0 × 10 ⁻¹⁰
Oxygen	11.5 × 10 ⁻¹⁰

*To convert to cm³/100 in²·s·atm, multiply by 3.2808.

Figure 13. Water Vapor Transmission Rate of DuPont FEP Film at -6°C (19°F) (ASTM E-96 Modified)



Note: Values are average only and not for specification purposes. To convert the permeation values for 100 in² to those for 1 mil, multiply by 15.5.

Table 7
Typical Vapor Transmission Rates of DuPont FEP Fluorocarbon Film, 25 μ m (1 mil) Thickness
(Test Method: Modified ASTM E-96)

Vapor	Temperature		Vapor Transmission Rate	
	°C	°F	SI Units (g/m ² ·s)	English Units (lb/100 in ² ·d)
Acetic Acid	35	95	6.3	0.41
Acetone	35	95	14.7	0.95
Benzene	35	95	9.9	0.64
Carbon Tetrachloride	35	95	4.8	0.31
Ethyl Acetate	35	95	11.7	0.76
Ethyl Alcohol	35	95	10.7	0.69
Freon® R-12	33	91	372.0	24.0
Hexane	35	95	6.7	0.43
Hydrochloric Acid	25	77	<0.2	<0.01
Nitric Acid (Red Fuming)	25	77	180.0	10.5
Sodium Hydroxide, 50%	25	77	<0.2	<0.01
Sulfuric Acid, 98%	25	77	2 × 10 ⁻⁴	1 × 10 ⁻⁴
Water	39.5	103	7.6	0.49

CRITICAL TEMPERATURE DATA ON KAPTON

CRITICAL TEMPERATURE DATA ON KAPTON					
CRITICAL	TEMP.	TEMP.	TEMP.	TEMP.	TEMP.
1. 100	100	100	100	100	100
2. 100	100	100	100	100	100
3. 100	100	100	100	100	100
4. 100	100	100	100	100	100
5. 100	100	100	100	100	100
6. 100	100	100	100	100	100
7. 100	100	100	100	100	100
8. 100	100	100	100	100	100
9. 100	100	100	100	100	100
10. 100	100	100	100	100	100
11. 100	100	100	100	100	100
12. 100	100	100	100	100	100
13. 100	100	100	100	100	100
14. 100	100	100	100	100	100
15. 100	100	100	100	100	100
16. 100	100	100	100	100	100
17. 100	100	100	100	100	100
18. 100	100	100	100	100	100
19. 100	100	100	100	100	100
20. 100	100	100	100	100	100
21. 100	100	100	100	100	100
22. 100	100	100	100	100	100
23. 100	100	100	100	100	100
24. 100	100	100	100	100	100
25. 100	100	100	100	100	100
26. 100	100	100	100	100	100
27. 100	100	100	100	100	100
28. 100	100	100	100	100	100
29. 100	100	100	100	100	100
30. 100	100	100	100	100	100
31. 100	100	100	100	100	100
32. 100	100	100	100	100	100
33. 100	100	100	100	100	100
34. 100	100	100	100	100	100
35. 100	100	100	100	100	100
36. 100	100	100	100	100	100
37. 100	100	100	100	100	100
38. 100	100	100	100	100	100
39. 100	100	100	100	100	100
40. 100	100	100	100	100	100
41. 100	100	100	100	100	100
42. 100	100	100	100	100	100
43. 100	100	100	100	100	100
44. 100	100	100	100	100	100
45. 100	100	100	100	100	100
46. 100	100	100	100	100	100
47. 100	100	100	100	100	100
48. 100	100	100	100	100	100
49. 100	100	100	100	100	100
50. 100	100	100	100	100	100
51. 100	100	100	100	100	100
52. 100	100	100	100	100	100
53. 100	100	100	100	100	100
54. 100	100	100	100	100	100
55. 100	100	100	100	100	100
56. 100	100	100	100	100	100
57. 100	100	100	100	100	100
58. 100	100	100	100	100	100
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60. 100	100	100	100	100	100
61. 100	100	100	100	100	100
62. 100	100	100	100	100	100
63. 100	100	100	100	100	100
64. 100	100	100	100	100	100
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66. 100	100	100	100	100	100
67. 100	100	100	100	100	100
68. 100	100	100	100	100	100
69. 100	100	100	100	100	100
70. 100	100	100	100	100	100
71. 100	100	100	100	100	100
72. 100	100	100	100	100	100
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79. 100	100	100	100	100	100
80. 100	100	100	100	100	100
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82. 100	100	100	100	100	100
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86. 100	100	100	100	100	100
87. 100	100	100	100	100	100
88. 100	100	100	100	100	100
89. 100	100	100	100	100	100
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92. 100	100	100	100	100	100
93. 100	100	100	100	100	100
94. 100	100	100	100	100	100
95. 100	100	100	100	100	100
96. 100	100	100	100	100	100
97. 100	100	100	100	100	100
98. 100	100	100	100	100	100
99. 100	100	100	100	100	100
100. 100	100	100	100	100	100



3713 2090

Continental®

TEVES

Continental
Automotive Systems
Business Unit

Telefax

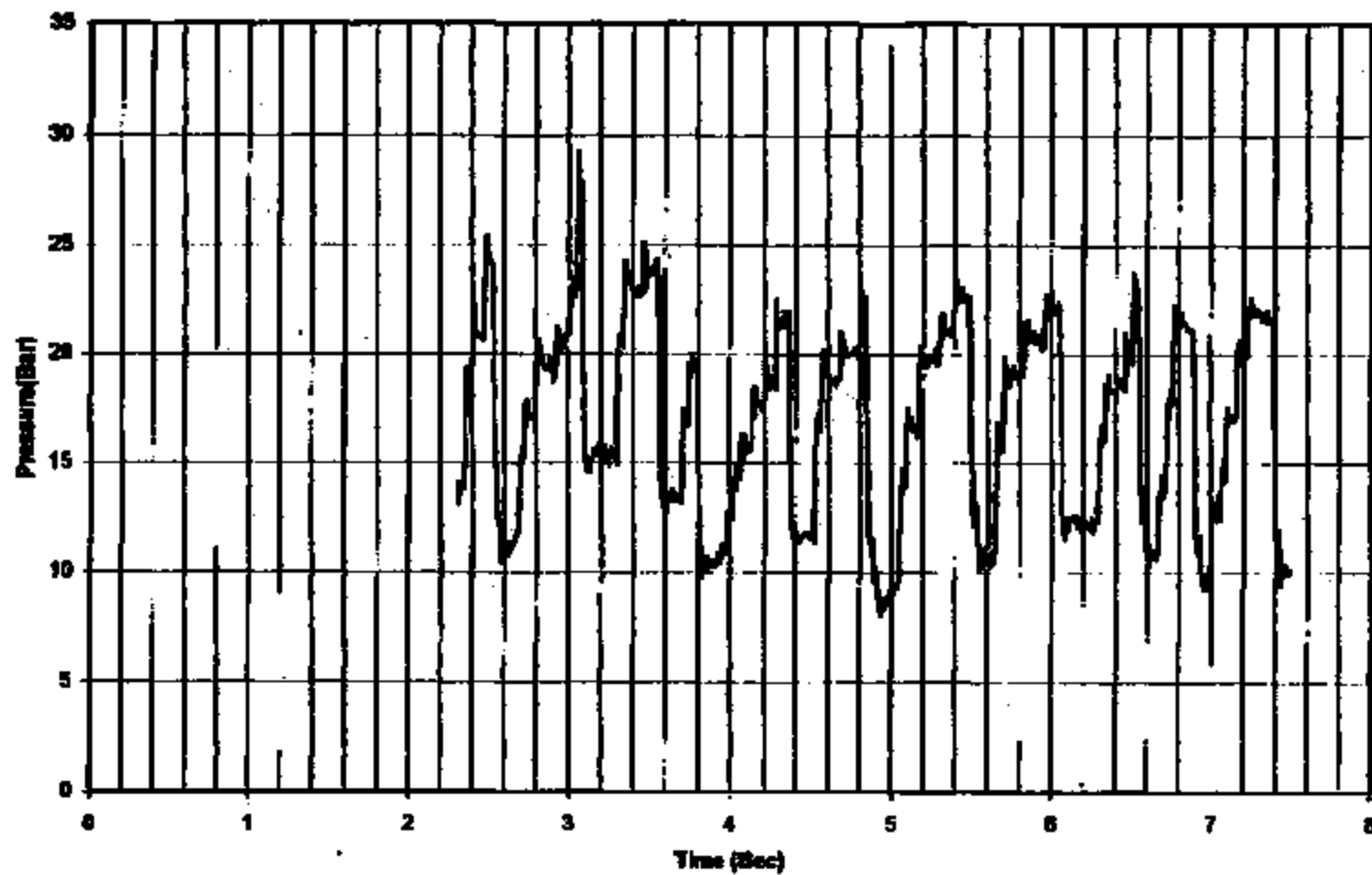
To	Joe Evans	From	Brian Hildebrand
Company		Dept.	
Dept.		Fax No.	
Fax No.		Phone No.	
Date	3/5/99	Pages including cover sheet	

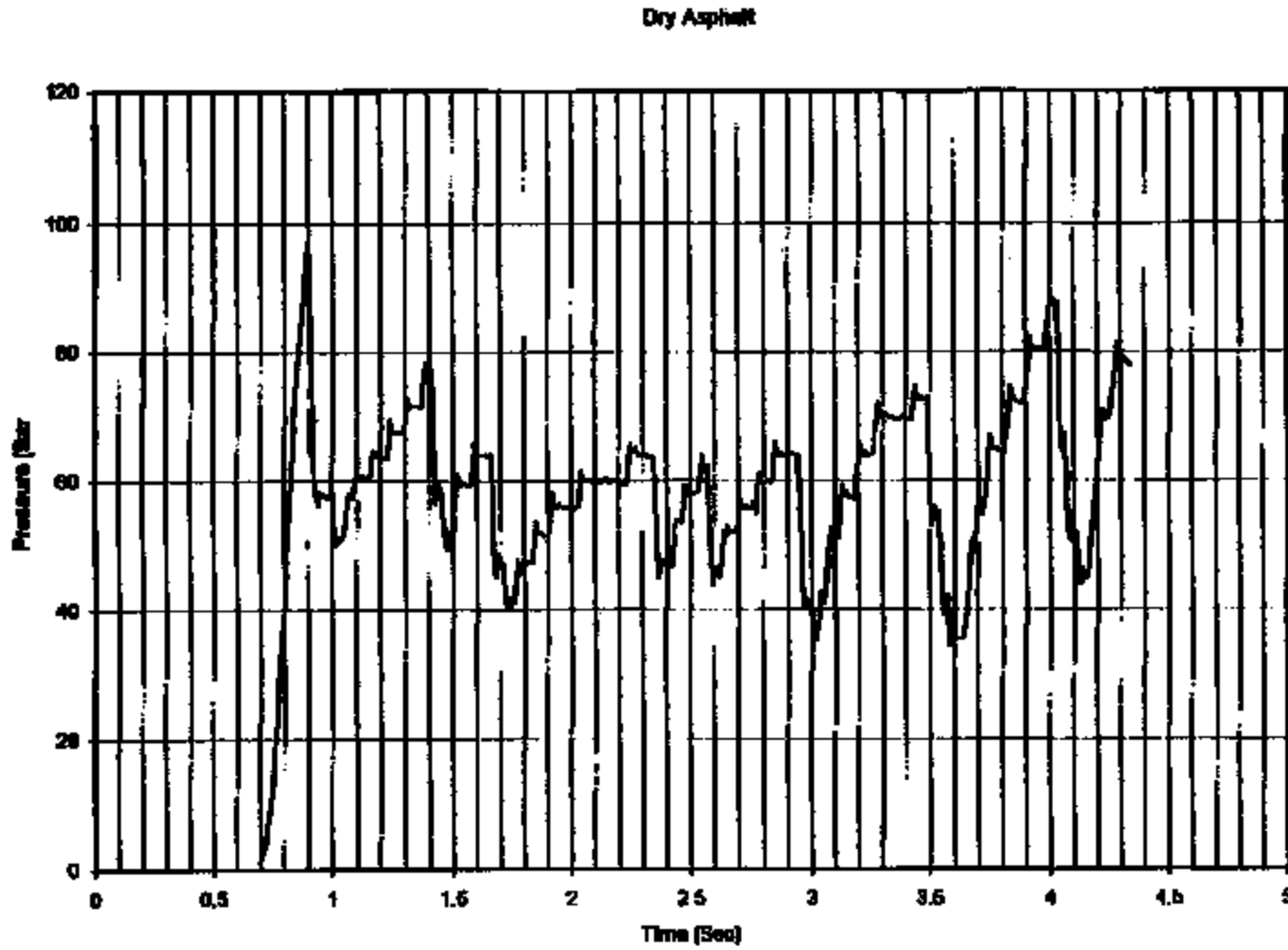
Typical ABS Rear Axle
Pressure traces.

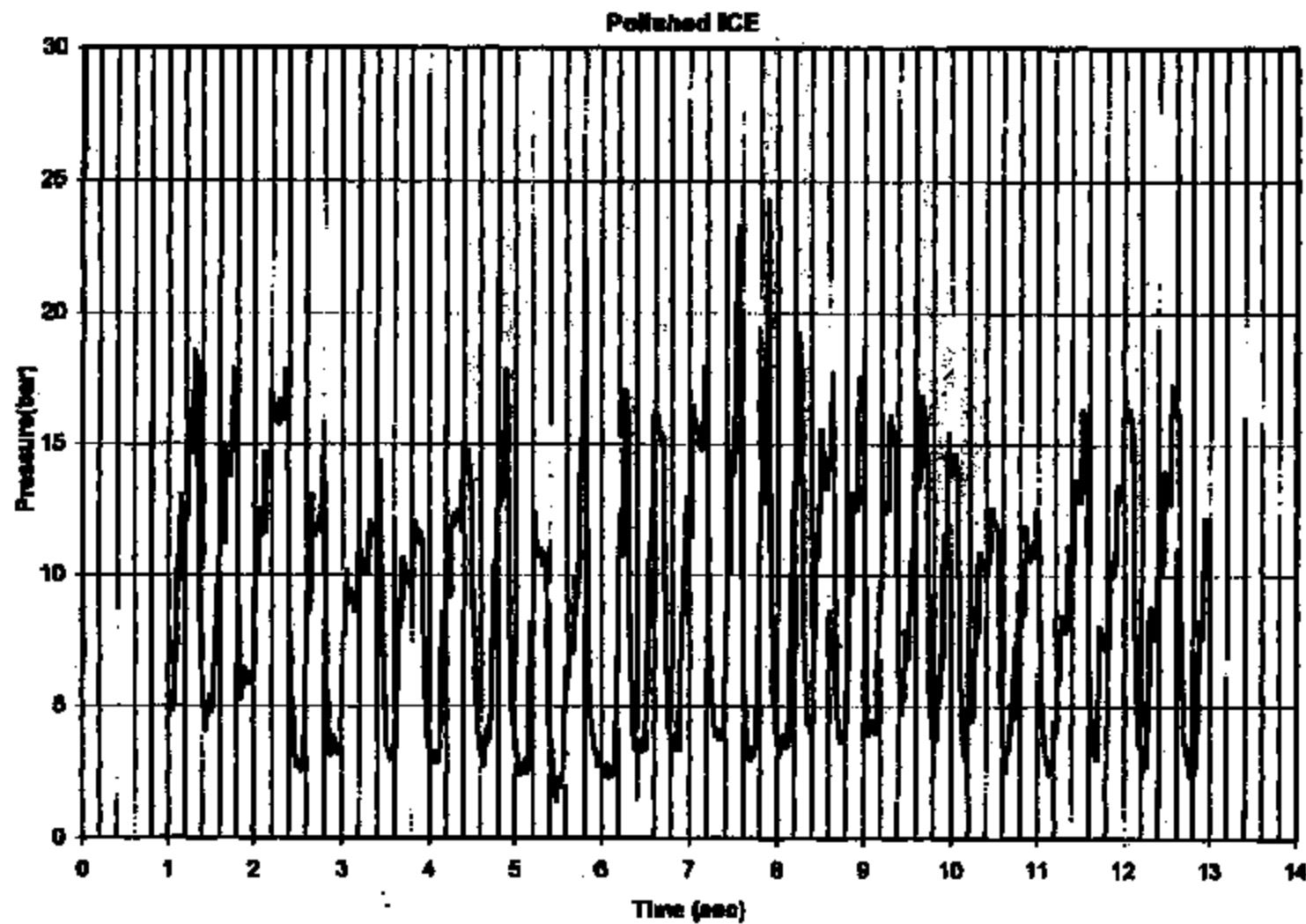
- Dry Asphalt
- Snow
- ice

Not for
MY 92 & 93,
but close.
Steve

Packed Snow









3713 2095

3713 2088

* See next page

22-10
22-10
22-10
22-10



Sensor
Foglet's

Veh off
4th Street
Kurtz
no close
transfer
hand.

NOT
SUSPICIOUS

Brake Fluid

Engine Oil

Adjuvant Fire

Electrical Wire

Gasoline Heating

Plastic Bag

Engine Fluid

Brake Fluid

Source A

Source B

3713 2087

Pauline & Arthur Stone

$$\frac{V_{B47}}{54 \text{ mV}} (0.8) = \frac{12 \text{ V}}{15}$$

Resistance
 breathing
 BP 120/80

UNWANTED
CRT CIG short to ground
SLED control short ground

GROUP PART

Normal - Support to Prop-Valve to
Bracket and tubing to form

4/29/99

~~3/22/99~~

SIR

~~Normal~~
Vehicle Battery.
(NOT ALL-TIME Circuit)
~~START-STOP CIRCUIT~~



1111

1111

1111

ADDITIONAL



