ITT Industries

ITT Aerospace Controls

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Analysis Completion Date: February 14, 2003
Initial Submission Date: September 17,2002

Subject : Analysis of pressure switches 1103P26-1 (2 each) and 1103P26-19 (2 each)

Participants: The following personnel were present at ITT Aerospace Controls to perform an Engineering Investigation of the subject switches.

Name	Company	Organization	Phone	e-mail
Doug Orchard	FAA	MIDO		
John Krochmal	ITT (point of contact)	Quality Engineering	661-295-4161	John_krochmal@fluids.ittind.com
John Foster	ITT	Manufacturing Engineering	See ITT point of contact	See ITT point of contact
Wayne Okuma	ITT	Manufacturing Engineering	See ITT point of contact	See ITT point of contact
Mostafa Donyanavard	ITT	Design Engineering	See ITT point of contact	See ITT point of contact
Jerry Hall	ITT (point of contact)	Quality Control	661-295-4166	Jerry_hall@fluids.ittind.com
David Winter	ITT	Reliability Engineering	See ITT point of contact	See ITT point of contact

Background:

The following information was derived from the report, CH102FA199.

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Analysis:

The above listed personnel met at ITT to observe and document the external and functional condition of the switches as recovered from the accident site. The following actions were performed with the associated documented results.

1) A review of the accident report was undertaken including a call to Mr. Silliman from the NTSB.

   Results: An understanding of the accident scenario was established. Two assemblies were examined labeled "Right" and "Left". Each assembly contained both a 1103P26-1 and 1103P26-19 switch. The assembly labeled, "Right", was badly burned as evidenced in the following photos. Both banks of switches were exposed to high temperature and the shock from the accident. The switch identification and as assembled locations are as follows:

Part Number	Serial Number	Assembly Date	Assembly Location
1103P26-1	3987	1Q93	Left Assembly
1103P26-19	10743	4Q96	Left Assembly
1103P26-1	4020	1Q93	Right Assembly
1103P26-19	12176	3Q99	Right Assembly

Table 1 – Identification Information

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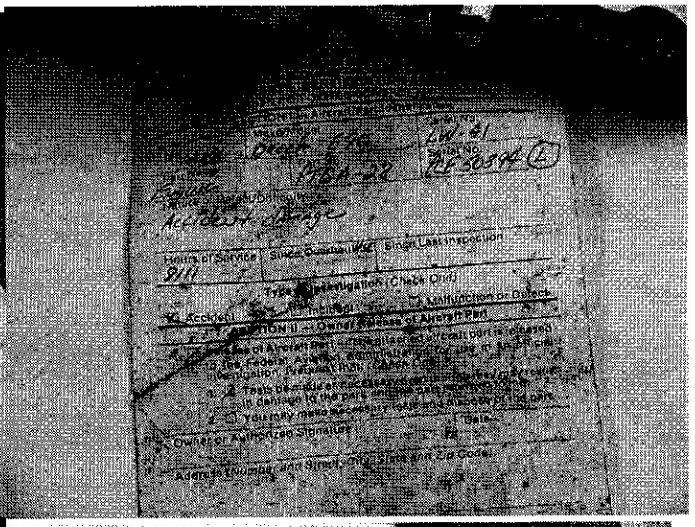
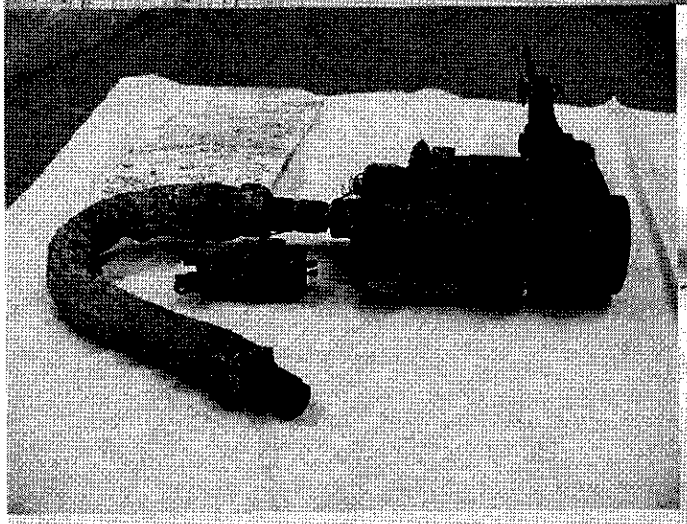
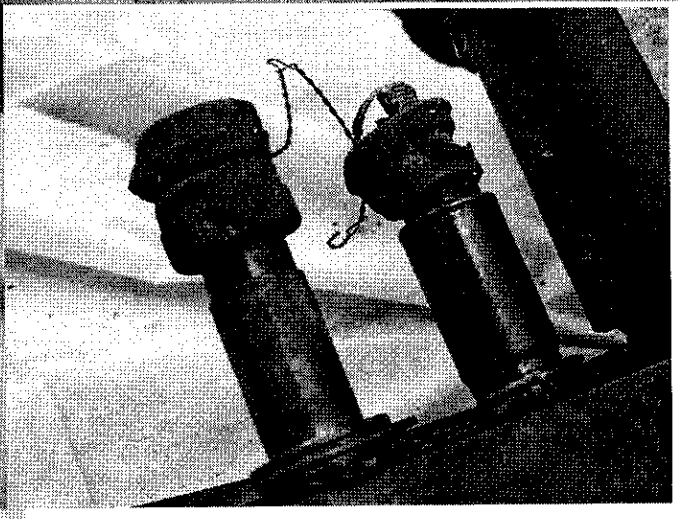
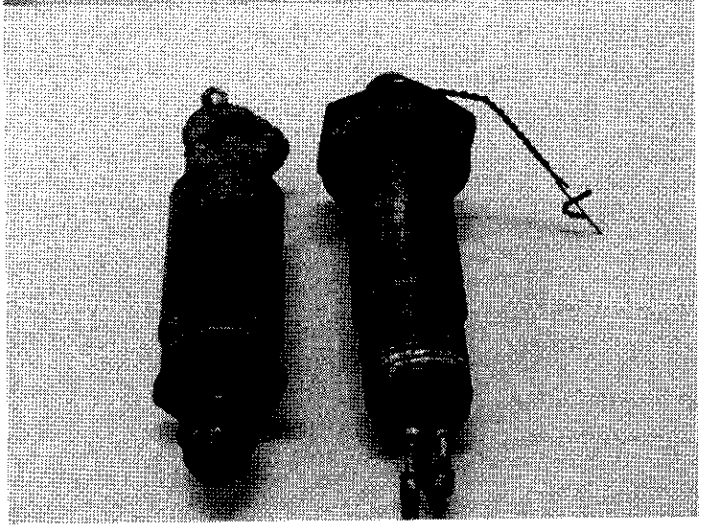
Right Assembly









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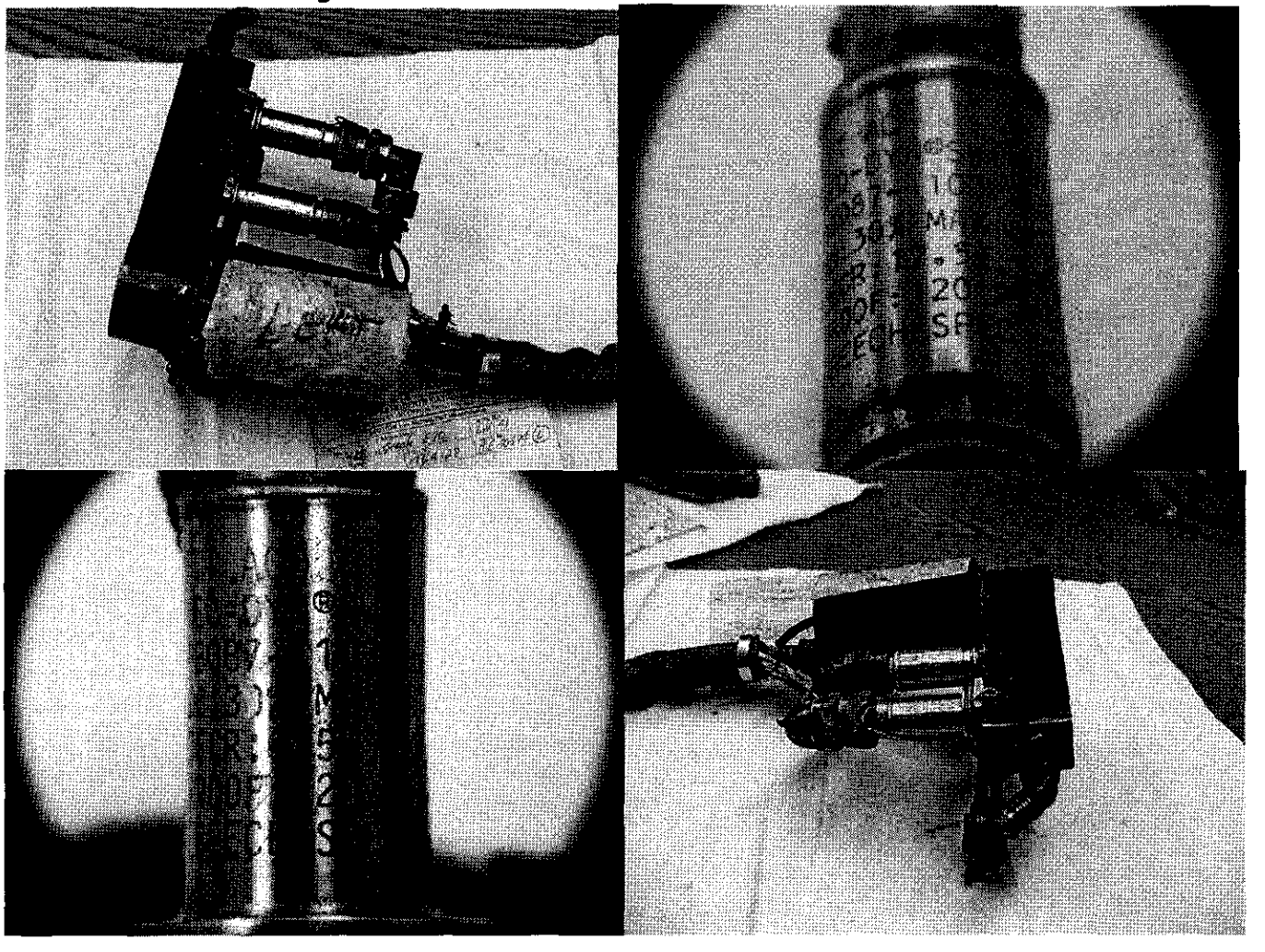
Left Assembly



Next the switches were removed from the assemblies and subjected to functional testing per the approved acceptance test procedure. See figures 3. The Interface Control Drawing for the 1103P26-X switches is indicated in figure 1. Due to the condition of the switches on the right assembly, functional testing was not possible. The wires were shorted together from exposure to extreme heat. The test data is summarized as follows:

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Part Number	Serial Number	Decreasing Actuation Pressure **Specification (psig)**	Decreasing Actuation Pressure Actual value (psig)	Increasing Pressure Actual value (psig)	Deadband **Specification** (psig)	Deadband Actual value (psig)
1103P26-1	3987	6.5 +/- .5	3.33	4.73	.99	1.40
1103P26-19	10743	12.5 +/- .5	7.22	8.99	2.17	1.77
1103P26-1	4020	6.5 +/- .5	Unable to Read	Unable to Read	Unable to Read	Unable to Read
1103P26-19	12176	12.5 +/- .5	Unable to Read	Unable to Read	Unable to Read	Unable to Read

Table 2 – Functional test results

As observed from Table 2, the decreasing pressure setpoints from both switches on the, "Left", assembly were below specification. Also as indicated in Table 2, the deadband reading of serial number 3987 exceeded specification and the deadband reading of serial number 10743 was within specification. The switches from the, "Right", assembly were pressurized and the technician listened for an audible sound that might indicate the mechanical portion of the switch was functioning. An audible noise was detected while pressurizing both switches between 16 and 22 psig. All switches were also determined not to leak.

The results of this investigation were discussed with Mr. Silliman and he was advised that further analysis would require disassembly of switches and would result in irreversible changes.

The following activity was performed on February 14, 2003 and constitutes the additions made to the original report on September 17, 2002.

On February 14, 2003 the switches were hand carried to ITT by Mr. Doug Orchard for further teardown and visual examination of the internal components. The connectors were removed from the switches from the left assembly and the soldered connector terminals were examined. The connections appeared to have been exposed to excessive heat as evidenced by the condition of the soldered terminals, see figure 4. Although it appeared that the terminal connections were slightly reflowed all nodes were intact and functional.

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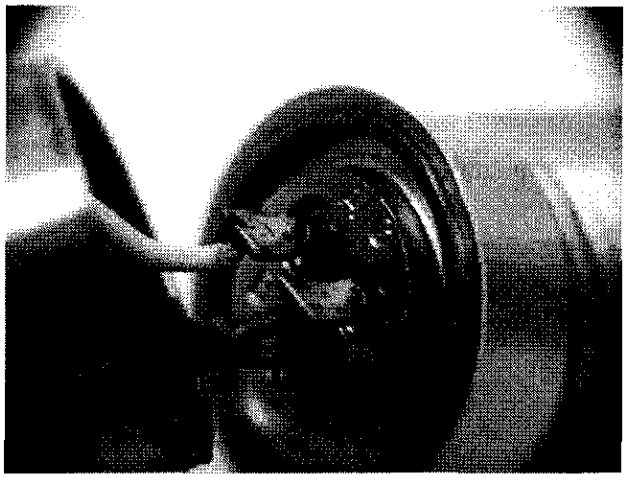
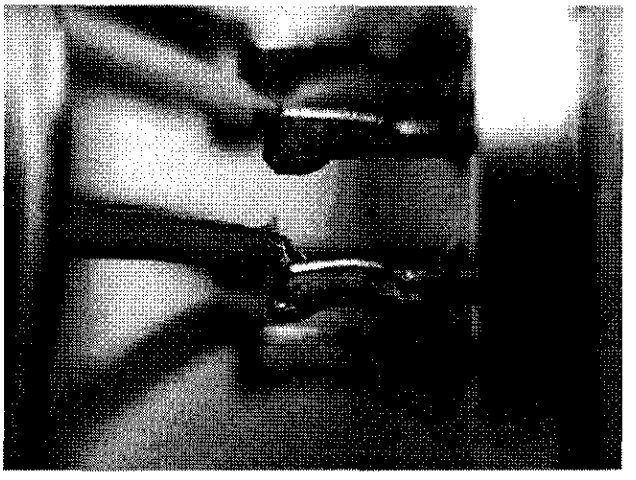


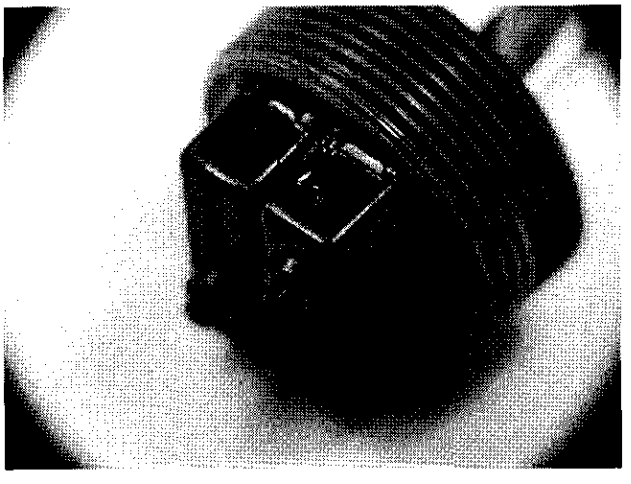
Close-up of solder connection shows area of solder re-flow.



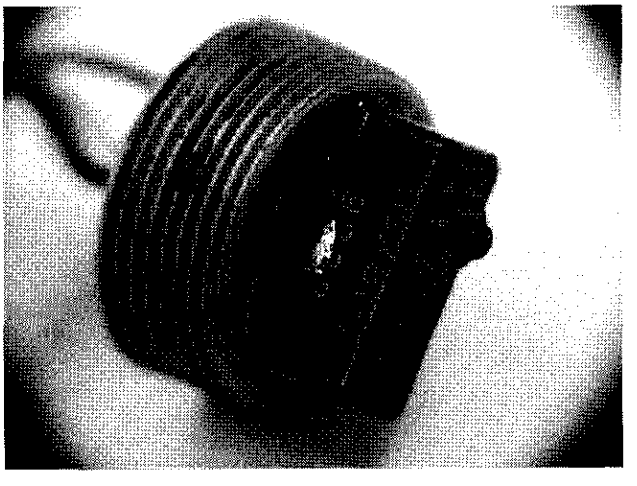
Different photo angle showing solder re-flow

Figure 4 Soldered Connector Terminals Indicating Excessive Heat Exposure

The mechanical switch components were manually actuated and were functional except for the setpoint shifts previously identified. The microswitches were removed from the switch bodies and visually examined and functionally tested. No damage was observed and the microswitches functioned normally, see figure 5.



Dual Micro Switch.



Single Micro

Figure 5 Microswitches

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After removing the microswitches the brass retainers were removed from the switch bodies and examined. Both retainers appeared slightly tarnished as compared with a new retainer indicating exposure to excessive heat, see figure 6.

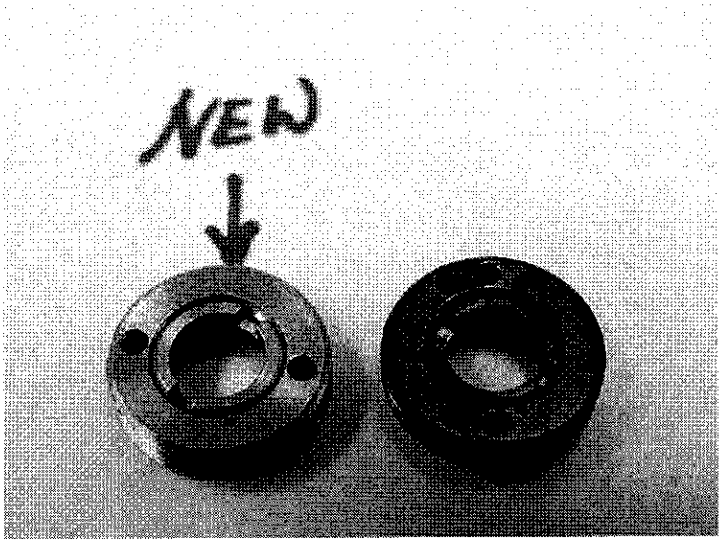
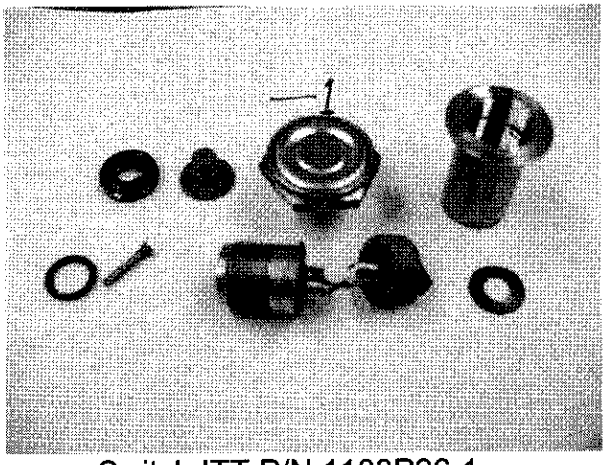
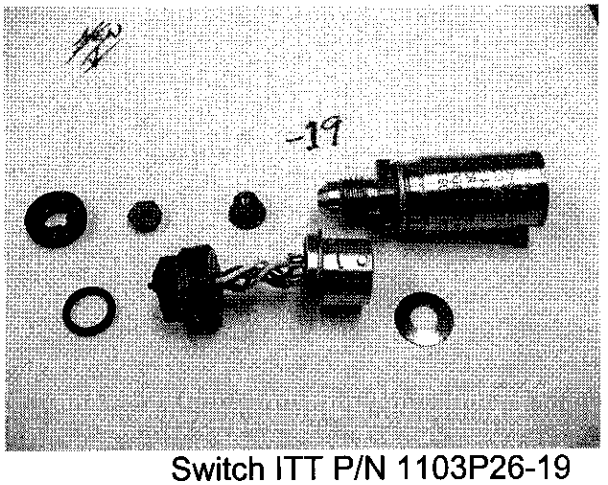


Figure 6: Retainer indicating excessive heat exposure Side by comparison

The unit on the left is a new part. The unit on the right is from the switch under analysis. The diaphragms, belleville springs, stops, actuation shoes were then removed and examined for signs of damage. No damage was observed and were functional, see figure 7.



Switch ITT P/N 1103P26-1



Switch ITT P/N 1103P26-19

Figure 7 Disassembled switches

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Conclusion: No overt damage to the switches or internal components thereof from the left assembly was observed. However the reflow condition of the connector terminals of both switches coupled with the discoloration of the brass retainers indicates the switches from this side were also exposed to excessive heat. After conferring with ITT Engineering it was determined that excessive heat exposure, beyond performance specification, can result in changes in the elasticity characteristics of the retaining diaphragm and result in the observed changes in setpoint. No other conclusions regarding the aircraft accident were evident from this analysis due to the condition of the switches received.

If there are any questions regarding the information in this report please contact John Krochmal at [redacted] or Jerry Hall at [redacted]