

ATTACHMENT A

Airplane Differences Report

EUROPEAN AVIATION SAFETY AGENCY



**TBM 700-A
TBM 700-B
TBM 700-C1
TBM 700-C2
TBM 700-N**

**Dated, 25 September 2008
Initial**

**European Aviation Safety Agency
Postfach 10 12 53
D-50452 Köln, Germany**

www.jaat.eu

European Aviation Safety Agency
Operational Evaluation Board – TBM 700 A/B/C1/C2/N

Revision Record

Revision No.	Section	Pages No.	Date	Published
Draft	OEB report	1 to 16	03/07/08	July 2008
Initial	Report	1 to 16	25/09/08	25/09/2008

European Aviation Safety Agency
Operational Evaluation Board – TBM 700 A/B/C1/C2/N

Contents

Revision Record	2
Contents	3
Joint Operation Evaluation Board – FCL	4
JOEB Composition	5
Preamble	6
Acronyms.....	7
Executive Summary	8
1) Purpose of the document:	9
2) Description of TBM 700:.....	9
2.1) TBM700 C1: the Base Aeroplane.....	10
2.2) TBM700 C2 version.....	10
2.3) TBM700 N version (trade name: TBM850).....	10
3) Aeroplanes differences:	11
4) Operator Difference Requirement (ODR) Tables:.....	12
5) Operator Difference Requirement (ODR) Tables for optional equipments specific to some versions:	12
6) Master differences requirements:.....	13
7) Licence endorsement.....	14
8) Specification for training.....	14
8.1 Pre-requisite	14
8.2 Special emphasis training.....	14
8.3 Class rating training program.....	14
8.4 Familiarisation training program	16
9) Specification for checking	17
9.1: Skill test	
9.2: Proficiency check	
10) Appendices	
APPENDIX 1 : Initial training course syllabus	
APPENDIX 2 : Familiarisation training course-syllabi	
APPENDIX 3 : Intentionally left blank	
APPENDIX 4 : ODR Tables	
APPENDIX 5 : Optional equipement	

European Aviation Safety Agency
Operational Evaluation Board – TBM 700 A/B/C1/C2/N

Joint Operational Evaluation Board – FCL

Capt. Michel Bédrine
JOEB Chairman

Jean Pierre Mesure
DGAC-F

Jean Baril
Pilot Training Courses Manager
EASA – Certification Flight Standards

Report prepared and submitted by:

Michel Bédrine
JOEB Chairman
Dated: 03.07.08



European Aviation Safety Agency
Operational Evaluation Board – TBM 700 A/B/C1/C2/N

JOEB Composition

Name	Capacity	Office/Branch	Postal Address
Bédérine Michel	JOEB Chairman	DGAC-F	50 rue Henry Farman 75015 Paris
Mesure Jean-Pierre	Type rating course advisor	DGAC-F	50 rue Henry Farman 75015 Paris

European Aviation Safety Agency
Operational Evaluation Board – TBM 700 A/B/C1/C2/N

Preamble

This Joint Operational Evaluation has been performed by a team composed of two DGAC-F experts.

The evaluation of the TBM 700 variants has been performed in compliance with JAR FCL1, the JAA JOEB Terms of References, the JOEB Handbook, dated 01/02/06 and the Common Procedures Document for conducting Operational Evaluation Boards, dated June 10, 2004.

This report specifies the EASA/JAA minimum requirements for the Initial Class Rating training course, Checking and Currency on the TBM700-A, TBM700-B, TBM700-C1, TBM700-C2, TBM700-N, as aircraft variants.

Training course in develop in appendix 1 and TBM "flight instructor training manual" will be available to EADS/SOCATA

EASA recommends the approval of the Socata proposed training course for initial class rating and familiarisation training between the TBM700-A, TBM700-B, TBM700-C1, TBM700-C2 and TBM700-N.

EASA recommends the referenced Socata ODR tables for approval.

EASA recommends a single licence endorsement **-TBM** - (same pilot class rating) for the TBM 700-A, TBM700-B, TBM700-C1, TBM700-C2 and TBM700-N.



Evan Nielsen

EASA Certification Directorate

Head Certification Flight Standards

European Aviation Safety Agency
Operational Evaluation Board – TBM 700 A/B/C1/C2/N

Acronyms

Air Cond. = Air Conditioning system
CBT = Computer Base Training
DGAC – F = Direction Général de l'Aviation Civile (France)
EADS = European Aeronautic Defence and Space company
EASA = European Aviation Safety Agency
EFIS = Electronic Flight Instrument Systems
FCL = Flight Crew Licensing (JAA regulation)
FMS = Flight Management System
HPA = High Performance Aircraft
IFR = Instrument Flight Rules
IHAS = Integrated Hazard and Awareness System
IR = Instrument Rating
ITT = Inter-turbine Temperature
JAA = Joint Aviation Authorities
JOEB = Joint Operational Evaluation Board
MLW = Max Landing Weight
MTOW = Max Take Off Weight
ODR = Operator Difference Requirement
OE = Operational Evaluation
P&WC = Pratt & Whitney Canada
PF = Pilot Flying
POH = Pilot Operating Handbook (or Flight Manual)
TCAS = Traffic Collision Avoidance System
VFR = Visual Flight Rules
Vs0 = flaps take off stall speed

Executive Summary

The Operational Evaluation (OE) was conducted for the TBM 700 N (trade name TBM 850) on EADS Socata request to EASA Certification Flight Standards and a catch-up procedure was set up for the TBM 700 A/B/C1/C2 by DGAC-F and EASA

EADS Socata proposed that the -TBM family -shares the same class rating and that the base aircraft and all the variants can have a single licence endorsement.

The TBM 700-C1 has been chosen as base aircraft for comparison purposes. The evaluation has essentially consisted in comparing the **TBM 700-C2 and TBM700-N systems** to the **-base aircraft systems** - for the aerodynamics is identical for all and the power excess available on the 850 HP-versus 700 HP- is only used for climb and cruise in clean configuration.

The Operational Evaluation team determined that the maximum level of differences existing between the TBM 700 C1/C2 and N was **level B**. Therefore, aided instruction was considered adequate to cover differences when transitioning from one variant to another one. Special attention is drawn that additional familiarisation training may be required depending the customisation of the aircraft.

This aircraft is Type certificated day/night VFR and day/night IFR operations but EADS Socata requires as prerequisites before initial training course 500H flight experience as Pilot In Command or as PF (in multi-crew operation) and a valid Instrument Rating.

JAR-FCL 1.251 requirements has to be fulfilled according to the High Performance Aeroplane and a HPA completion course certificate or theoretical ATPL credit must be held.

European Aviation Safety Agency
Operational Evaluation Board – TBM 700 A/B/C1/C2/N

1) Purpose and applicability:

The purpose of this document is to present the Operator Difference Requirements (ODR) tables (General, Systems and Manoeuvre) related to TBM 700.

Variants addressed are TBM 700-A, TBM 700-B, TBM 700-C1, TBM 700-C2 and TBM 700-N. A short analysis demonstrates that TBM 700-A, TBM 700-B and TBM 700-C1, can be chosen as the base aeroplane, designated TBM 700-C1.

Comparison will be done between TBM 700-C1 / TBM 700-C2 (appendix 4-1) and TBM 700-C1 / TBM 700-N (appendix 4-2).

To complete the analysis between all family, ODRs table have been also done between TBM 700-C2 and TBM 700-N (appendix 4-3)

All optional equipment are addressed through a specific ODR table (appendix 5) and can be installed on customer's request.

Garmin 1000 equipment is not included in this evaluation.

2) Description of TBM 700:

The TBM700 is a 6/7 seat, low wing, pressurised, aeroplane powered by a Pratt & Whitney PT6A, with a 4 bladed constant speed Hartzell propeller.

This aeroplane, for which the program was launched in 1987 and FAR23 Type Certificated in 1990, is the first single pilot single-engine turboprop in the world.

Built mainly of conventional aluminium alloys, the TBM uses advanced composites in certain areas.

Flight controls are operated through conventional cable systems connected to rudder pedals and wheel control for aileron and elevator. The aerodynamically optimised wing of the TBM shares the same airfoil as new-generation regional aircraft. Wing leading edges are made of carbon fibre for lightness, strength and ice protection. Empennage components are constructed with metal bonded honeycomb sandwich.

The TBM700's avionics suite is built around proven standard equipment for general aviation:

- 2 CRT (Cathodic Ray Tube) colour electronic flight instrument systems (EFIS),
- Digital autopilot,
- Honeywell integrated Hazard and Awareness System (IHAS 8000),
- Shadin ETM700-Trend monitoring system, which enables the pilot to monitor the engine in real time properly.

European Aviation Safety Agency
Operational Evaluation Board – TBM 700 A/B/C1/C2/N

2.1) TBM700 C1: the Base Aeroplane

The TBM700 (A, B and C1 versions) has the following main characteristics:

- P&WC PT6A64 turbine engine (700shp),
- MTOW: 2984 kg,
- Vs0 at 61kt.

The slight differences between TBM700 A, B and C1 versions are summarized in table in § 3 below.

This TBM700, including versions A, B and C1, is designated as the Base Aeroplane. Very light differences are identified between versions A, B, C1 and Flight Manual reading is sufficient to fly anyone. This Base Aeroplane will further be called "TBM700 C1" and will also cover versions A and B.

2.2) TBM700 C2 version

The TBM700 C2 version is a very similar aircraft to the C1. The differences are:

- Reinforced landing Gears and associated structural parts,
- MTOW: 3354 kg,
- Vs0 : 65 kt (and associated airspeed indicator limitations).

2.3) TBM700 N version (trade name: TBM850)

The last version of TBM700, the "TBM700 N", compared to the C2 version, consists ~~more~~ specifically in the following :

- P&WC PT6A-66D turbine engine (850shp),
- power limitation system (850shp available only on "flaps up" phase of flight),
- new bleed air system,
- modified torque and ITT indicators,
- reinforcement of the engine mount,

In spite of the new TBM850 commercial designation given by SOCATA, this plane is accepted as a variant of the TBM700.

European Aviation Safety Agency
Operational Evaluation Board – TBM 700 A/B/C1/C2/N

3) Aeroplanes differences:

Summary of the differences between all versions of TBM700 aeroplane:

		TBM 700 A	TBM 700 B	TBM 700 C1	TBM 700 C2	TBM 700 N
Door	Small	X				
	Large		X	X	X	X
Oxygen	Chimical	X	X			
	Gazeous	X (optional)	X (optional)	X	X	X
Air Cond.	No air cond.	X				
	"Keith"		X			
	"Honeywell"			X	X	X
Weight	MTOW=2984kg MLW=2835kg	X	X	X		
	MTOW=3354kg MLW=3186kg				X	X
Engine	PT6 A 64 (700 shp)	X	X	X	X	
	PT6 A 66 D (850 shp)					X

NOTE 1:

TBM700 A, B and C1 versions are equipped with:

- small passenger door (A version involving different ditching emergency procedure)
- chemical oxygen (A and B versions)
- air conditioning (B – Keith – and C1 – Honeywell – versions)
- from serial number 1 (one) to serial number 17 (seventeen) (the first TBM700 A aeroplanes), radio master switch was not connected to the radio fan circuit breaker; "Radio master switch failure" emergency procedure was different.

The above listed differences between TBM700 A, B and C1 are not significant. TBM700 C1 is the BASE AEROPLANE.

As the TBM700 C1 is **the BASE AEROPLANE**, these particular systems are not necessary in the Operator Difference Requirement tables and self learning by reading the pilot operating handbook is sufficient.

NOTE 2:

Optional equipment is applicable on all versions (A,B, C1, C2 and N), listed in table 1 of § 5. They are part of the Base training when relevant except for those specified in table 2 of § 5 below. The optional equipments training is customized depending on the delivered aircraft configuration.

NOTE 3:

Note that, as the TBM700 is one certified Type/Model, TBM700 Serial Numbers are running from 1 to 9999 whatever is the version (A, B, C1, C2, N).

European Aviation Safety Agency
Operational Evaluation Board – TBM 700 A/B/C1/C2/N

4) Operator Difference Requirement (ODR) Tables:

See appendix 4

5) (ODR) Tables for optional equipments specific to some versions:

See appendix 5.

6) Master differences requirements:

AIRPLANE CLASS RATING: "TBM"						
		FROM AIRPLANE				
		TBM 700 A	TBM 700 B	TBM 700 C1	TBM 700 C2	TBM 700 N
TO AIRPLANE	TBM 700 A	N/A	A / A / A	A / A / A	A / A / A	B / A / A
	TBM 700 B	A / A / A	N/A	A / A / A	A / A / A	B / A / A
	TBM 700 C1	A / A / A	A / A / A	N/A	A / A / A	B / A / A
	TBM 700 C2	A / A / A	A / A / A	A / A / A	N/A	B / A / A
	TBM 700 N	B / A / A	B / A / A	B / A / A	B / A / A	N/A

Differences Definitions:

Definitions of Level A and B differences for Training/Checking/Currency are provided below for reference, as extracted from the OPS/FCL Common Procedures for conducting Operational Evaluation Boards, dated June 10, 2004.

Level A Training: Level A difference training is applicable to aircraft with differences that can adequately be addressed through self-instruction. Level A training represents a knowledge requirement such that, once appropriate information is provided, understanding and compliance can be assumed to take place. Compliance with Level A training is typically achieved by methods such as issuance of operating manual page revisions, dissemination of flight crew operating bulletins or differences handouts to describe minor differences between aircraft.

European Aviation Safety Agency
Operational Evaluation Board – TBM 700 A/B/C1/C2/N

Level A Checking: Level A checking indicates that no check related to differences is required at the time of differences training. A crewmember is, however, responsible for knowledge of each variant flown. Differences items should be included as an integral part of subsequent recurring proficiency checks.

Level A Currency: Level A currency is considered to be common to each variant. Thus, assessment or tracking of currency for separate variants is not necessary or applicable. Maintenance of currency in any one variant or a combination of variants suffices for any other variant.

Level B Training. Level B difference training is applicable to functionally similar aircraft with system or procedure differences that can adequately be addressed through aided instruction. At Level B aided instruction is appropriate to ensure crew understanding, emphasize issues, provide a standardized method of presentation of material, or to aid retention of material following training. Level B aided instruction typically employs means such as slide/tape presentations, computer based training (CBT), stand-up lectures, or video tapes.

Level B Checking. Level B checking indicates a "task" or "systems" check is required following transition and recurring differences training. Level B checking typically applies to particular tasks or systems such as INS, FMS, TCAS, or other individual systems or related groups of systems.

Level B Currency. Level B currency is "knowledge related" currency, typically achieved through self-review by individual crew members for a particular variant. Self-review is usually accomplished by review of material provided by the operator to crew members for that purpose. It may be undertaken at an individual crew member's initiative, but the operator must identify the material and the frequency or other situations in which the material should be reviewed. Self-review may be based on manual information, bulletins, aircraft placards, memos, class handouts, video tapes, or other memory aids that describe the differences, procedures, maneuvers, or limits for pertinent variant(s) that crews are flying.

7) Licence endorsement

1 Manufacturer	2 Aeroplanes		3	4 Licence endorsement
	Model	Name		
EADS Socata	TBM 700-A TBM 700-B TBM 700-C1 TBM 700-C2	TBM 700	(HPA)	TBM
	TBM 700-N	TBM 850		

8) Specification for Training

8.1: Pre-requisite

PREREQUISITES	
Before to begin initial training course pilot must comply with following prerequisites : 1 – Minimum experience : 500 hours as a Pilot In Command <u>or</u> as a PF (in multi-crew operation). 2 – Valid Instrument Rating certificate (I.R). 3 – First High Performance Airplane (H.P.A.) course completion <u>or</u> theoretical ATPL(A) credit. 4 – Valid PPL(A), CPL(A) or ATPL(A) licence. 5 – Valid medical class 1 or class 2 certificate.	

8.2 : Special emphasis training.

Slow flight should be trained and descent on a 5% slope in approach and landing configuration followed by go around.

Approach to stall should be trained in different configurations.

8.3: Class rating training program

INITIAL TRAINING COURSE			
	CONTENT	DURATION	REFERENCE
GROUND COURSE	- Description - Limitations - Normal procedures - Performances - Weight and balance - Emergency procedures - Cockpit training	3 days / 16 hours	P.O.H. : Pilot Operating Handbook
GROUND COURSE FINAL TEST	50 Multiple Choice Questions	1 hour 30	
AEROPLANE FLIGHT TRAINING	7 flights	4 days / 8 hours	
SKILL TEST	1 flight	1 hour	Appendices 1and 3 to JAR- FCL 1.240

European Aviation Safety Agency
Operational Evaluation Board – TBM 700 A/B/C1/C2/N

For detailed initial training course syllabus, see appendix 1

European Aviation Safety Agency
Operational Evaluation Board – TBM 700 A/B/C1/C2/N

8.4 : Familiarisation training programs

Base aeroplane	Difference aeroplane	Content	Duration	Reference
TBM 700 A TBM 700 B TBM 700 C1	TBM 700 C2	Depending of significant differences in following parts : - Description - Limitations - Normal procedures - Performances - Weight and balance - Emergency procedures	2H00	P.O.H : Pilot Operating Handbook
TBM 700 A TBM 700 B TBM 700 C1	TBM 700 N	Depending of significant differences in following parts : - Description - Limitations - Normal procedures - Performances - Weight and balance - Emergency procedures	3H30	P.O.H : Pilot Operating Handbook
TBM 700 C2	TBM 700 N	Depending of significant differences in following parts : - Description - Limitations - Normal procedures - Performances - Weight and balance - Emergency procedures	2H15	P.O.H : Pilot Operating Handbook

For detailed familiarisation course syllabus, see Appendix 2

Note : Additional familiarisation training may depend on optional equipment installed on specific variant, and must be completed in accordance with appropriate level of training (See appendix 5)

9) Specification for checking

9.1: Skill test

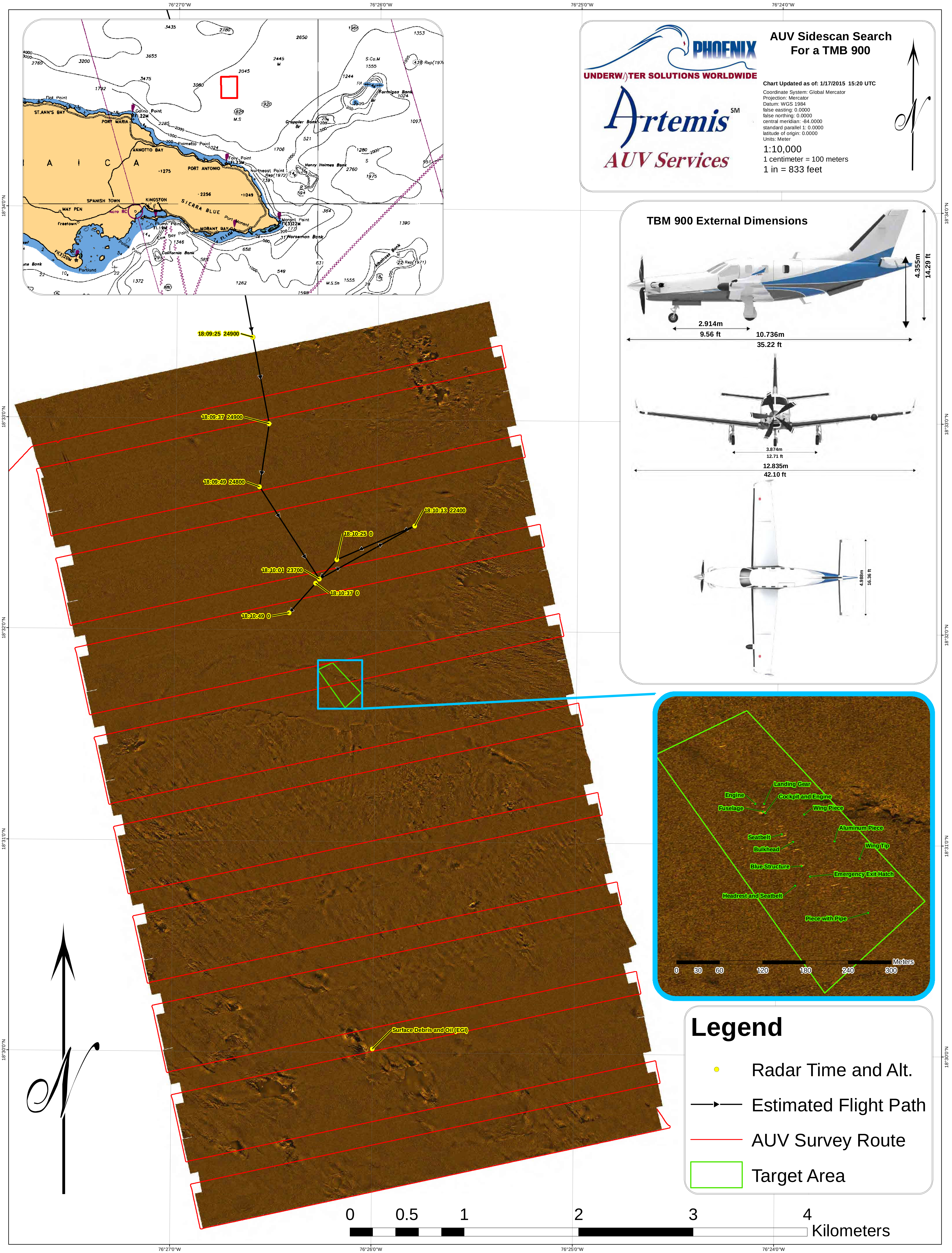
As required by JAR-FCL 1.240 and Appendix 1 and 3 to JAR FCL 1.240 and 1.295

9.2: Proficiency Checks

As required by JAR-FCL 1.245 and Appendix 1 and 3 to JAR FCL 1.240 and 1.295

ATTACHMENT B

Eclipse Underwater Illustration of Debris Field



ATTACHMENT C

GASC NVM Codes

@	current_leg_failure_word_1		
0x00008003	SW_ECS_HEATING_FAULT	0	3
	SW_BLEED_TEMP	1	
	SW_FCSOV_TM_CMD_F	2	
	SW_GF_FAILED	3	2
	SW_BDPS_FAULT	4	
	SW_BLEED_OVHT	5	
	SW_IPPS_FAULT	6	
	SW_BPV_POS_CMD_F	7	7
	SW_BPV_POS_FAULT	7	
0x00008002	SW_ECS_COOLING_FAULT	8	0
	SW_FF_SPEED_SEL_FAULT	9	
	SW_COCKPIT_TEMP_SEL_FAULT	9	
	SW_RF_SPEED_SEL_FAULT	10	
	SW_CABIN_TEMP_SEL_FAULT	10	0
	SW_COMP_OVHT_CONF_OBS	11	
	SW_HAD_POS_CMD_F	12	
	SW_HAD_POS_FAULT	12	
	SW_ITS_FAULT	13	
0x00008001	SW_FF_FAULT_CONF	14	0
	SW_RF_FAULT_CONF	15	
	SW_LPSW_COMP_OFF	16	0
	SW_LPSW_FAILED	17	
	SW_HPSW_COMP_OFF	18	
	SW_HPSW_FAILED	19	0
	SW_BCKTS_FAULT	20	
	SW_BCTS_FAULT	21	
	SW_CKVTS_FAULT	22	
0x00008000	SW_CVTS_FAULT	23	5
	SW_CPCS_FAULT	24	
	SW_CAB_ALT_SEL_FAULT	25	
	SW_PC_COMP_OOR	26	
	SW_OFV_TM_CMD_F	27	
	SW_GASC_FAULT	28	1

@	current_leg_failure_word_2		
0x00008007	SW_FMS_LAND_ELEV_F	0	8
	SW_AVIONICS_QNH_F	1	
	SW_AVIONICS_ZA_F	2	
	SW_AVIONICS_VZA_F	3	
		4	0
		5	
		6	
0x00008006		7	0
		7	
		8	
		9	
		9	0
		10	
		10	
		11	
		12	
0x00008005		12	0
		13	
		14	0
		15	
		16	
		17	
0x00008004		18	0
		19	
		20	
		21	
		22	0
		23	
		24	
		25	0
		26	
		27	
		28	0

ATTACHMENT D

Air Force Research Laboratory Report for Examination of
OTSW Switch Contacts

**Analysis of Over Temperature Switch (OTSW) Contacts
(Failure Analysis)**

26 February 2016

**Evaluation Report
(SA102002)**

Report No. AFRL/RXS 15-074

AUTHOR(S)


(University of Dayton Research Institute)
Materials Integrity Branch (AFRL/RXSA)
2179 12th Street
Wright-Patterson Air Force Base, Ohio 45433-7718

REQUESTER

**Robert L. Swaim
Systems Engineering, NRS
490 L'Enfant Plaza, E, SW
Washington DC 20594**

DISTRIBUTION STATEMENT F: Further dissemination only as directed by National Transportation Safety Board (February 2016) or DoD higher authority.

EXECUTIVE SUMMARY

The Air Force Research Laboratory/Materials Integrity Branch performed failure analysis on three sets of electrical contacts extracted from over temperature switches (OTSWs). The incident switch was removed from a private Daher-Socata TBM900 airplane as part of an accident investigation by the National Transportation Safety Board (NTSB) which had been removed after detection of inflight failures. The overall condition of the N900KN (incident) contacts was considered average. Though the contacts showed evidence of arc erosion, it was deemed typical for a used switch and not excessive. Material transfer between the two contacts was also not excessive. In addition, a black “halo” observed around the OTSW contacts’ mating surfaces was shown to be comprised of silicon dioxide (SiO₂), which is an electrical insulator.

ACKNOWLEDGMENTS

The author would like to thank Messrs. [REDACTED] and [REDACTED] (University of Dayton Research Institute) and [REDACTED] (University of Dayton Research Institute Analytical Laboratory) for their expertise in elemental analysis. The author would also like to recognize Ms. [REDACTED] (Materials Integrity Branch) for expert document preparation, formatting, and editing.

TABLE OF CONTENTS

	Page
PURPOSE.....	1
BACKGROUND	1
FACTUAL DATA	2
DISCUSSION	2
CONCLUSIONS.....	3
RECOMMENDATIONS.....	3
FIGURES	4
APPENDIX.....	12

Analysis of Over Temperature Switch (OTSW) Contacts

PURPOSE

Analyze switch contacts removed from an OTSW.

BACKGROUND

A Daher-Socata TBM900 aircraft, Registration No. N900KN, lost cabin pressurization on 5 September 2014 while en route to Florida after taking off from New York. It crashed in the ocean near Jamaica and was recovered from a depth of 10,000 feet after a prolonged period of time. The aircraft had 146 flight hours. Investigators from the National Transportation Safety Board (NTSB) recovered an OTSW that nonvolatile memory recorded opening immediately before the depressurization event began.

The OTSW, Honeywell Part No. A042010300-5, is a normally closed switch of a single pole, single throw configuration. It opens when it senses a temperature greater than $315^{\circ}\text{C} \pm 5^{\circ}\text{C}$ and closes when the temperature is less than 295°C . During manufacturing the OTSW housing is purged with nitrogen and sealed prior to final assembly, and then the adjacent portion of the housing is also nitrogen purged and sealed.

When installed on the aircraft, the OTSW senses the output air temperature of the bleed air system, and is wired in series with a shut-off valve (28 VDC, 55.6 Ω , 28 mH). During flight, 28 VDC is nominally applied to the OTSW/solenoid circuit by the Global Air System Controller (GASC), and flight testing found the OTSW steady state current of 0.4 ADC. When it senses a temperature greater than 315°C , which is considered an abnormal condition, the OTSW contacts will open. The GASC functions by monitoring the resistance of the OTSW to record whether the state of the switch is to be considered open or closed.

Data provided to AFRL/RXSA indicated that initial resistance measurements made when the switches were removed from non-accident airplanes were accomplished both with a handheld multimeter and later with a 4-wire micro-ohmmeter at Honeywell. Per the OTSW data sheet, the maximum contact resistance of the closed switch should be 0.125 Ω maximum.

During disassembly of the OTSW from the accident airplane at Honeywell, it was reported the internal chambers were found filled with sea water, and thus the electrical contacts were in direct contact with saltwater for an indeterminate amount of time. Resistance values measured before disassembly should be deemed invalid, as the measurements would have been corrupted by the presence of sea water.

When tested with a 4-wire micro-ohmmeter at Honeywell and using an excitation current of 1 ADC, the NTSB reported the OTSW switches at Honeywell registered a maximum of 0.2 Ω . The NTSB disassembled each OTSW and removed the electrical contacts contained within them prior to inspection at AFRL.

A photo and radiograph of the OTSW from the accident airplane was provided by the NTSB ([Figure 1](#)). There are two sealed chambers inside the unit – one for the lead wires/service loops, and the other to house the temperature sensor and switch contacts. [Figure 2](#) is a diagram showing how the switch operates. There are two contacts: a contact affixed to a movable armature and a stationary “kidney” contact. A bimetallic diaphragm “pops up” when $T > 315\text{ }^{\circ}\text{C}$ ($\pm 5\text{ }^{\circ}\text{C}$) and pushes up on the armature, thereby pivoting the armature counterclockwise and opening the switch contacts. The diaphragm “pops back down” when $T < 295\text{ }^{\circ}\text{C}$ and closes the switch contacts. [Figures 3](#) and [4](#) are close-up photos of the contacts in a non-incident OTSW, which further show the operating principles of the switch. These photos were also provided by the NTSB.

FACTUAL DATA

The NTSB removed three pairs of contacts from three OTSWs and physically carried them to the Materials Integrity Branch (RXSA) for analysis: N900KN (incident), 682 (exemplar), and 1038 (exemplar). Analysis tools used by RXSA included a Keyence VHX-5000 Digital Microscope, a JEOL JSM 6610LV Scanning Electron Microscope (SEM), and an EDAX Energy Dispersive Spectroscopy (EDS) system.

The overall condition all contacts were visually considered “average” and the Keyence was used for microphotography. Though the contacts showed evidence of arc erosion, it was not deemed excessive. Material transfer between the two contacts was typical for contacts which had been in service and no evidence of welded contacts was observed.

Elemental analysis using EDS showed the bulk composition of the N900KN and 682 contacts was silver. [Figure 5](#) contains digital microscope images of these contacts. The N900KN contacts had black speckles over the entire surface, which EDS showed to be chloride. The contact areas look similar for the N900KN and 682 contacts, each with low to moderate amounts of arc erosion. A black “halo” was present around each contact area. Elemental analysis on contacts 682 ([Appendix](#)) showed the halo on each contact was comprised of SiO_2 . The 1038 pair contacts (not shown) looked very similar to the 682 contacts, including the presence of the black halos. No actual silicon or silicone was found as oils or other discrete substances.

[Figure 6](#) contains SEM images of the N900KN and 682 contacts. As can be seen, the surface roughness and topology look similar for each.

DISCUSSION

The only significant difference observed between the contacts analyzed by RXSA was the presence of chloride on the N900KN contacts. The chloride presence is believed due to saltwater infiltration inside the incident OTSW while the aircraft was at the bottom of the ocean.

Though elemental analysis was only performed on the black halos around the mating surfaces for the 682 contacts, the same halo was visually observed on the N900KN and 1038 contacts. An excessive buildup of solid SiO_2 , deposited when an arc forms in an atmosphere

containing gaseous silicon, could potentially cause the contact resistance to significantly increase beyond the manufacturer's specification when the switch is in the closed state.

CONCLUSIONS

The overall condition of the N900KN (incident) contacts were considered "average." Though the contacts showed evidence of arc erosion, it was not deemed excessive. Material transfer between the two contacts was also not excessive.

The black halos around the mating areas for one of the exemplar contacts were comprised of SiO_2 . AFRL/RX was unable to determine if the presence of SiO_2 adversely affected switch performance. If the halos observed on other contacts are also comprised of SiO_2 , it is an indication silicon may be systematically present in a population of OTSWs.

RECOMMENDATIONS

Due to the reactance of the shut-off valve, consider installing a snubber component or circuit in parallel with the shut-off valve or in parallel with the OTSW. This will reduce the arcing energy across the OTSW contacts when they open, thereby minimizing arc erosion and the deposition of SiO_2 . While a 1000 V silicon diode (e.g., 1N4007) will likely offer better performance than a resistor-capacitor circuit, the former may not allow the system to pass electromagnetic interference testing due to the high levels of reverse voltage applied during testing. Consideration must also be given to how the inclusion of a snubber component or circuit would affect the overall reliability of the system, and whether or not its inclusion is fail-safe. If a snubber cannot be installed, consider changing the composition of the contacts in the OTSW to an alloy that is more arc-resistant, such as silver cadmium oxide or silver tin oxide.

FIGURES

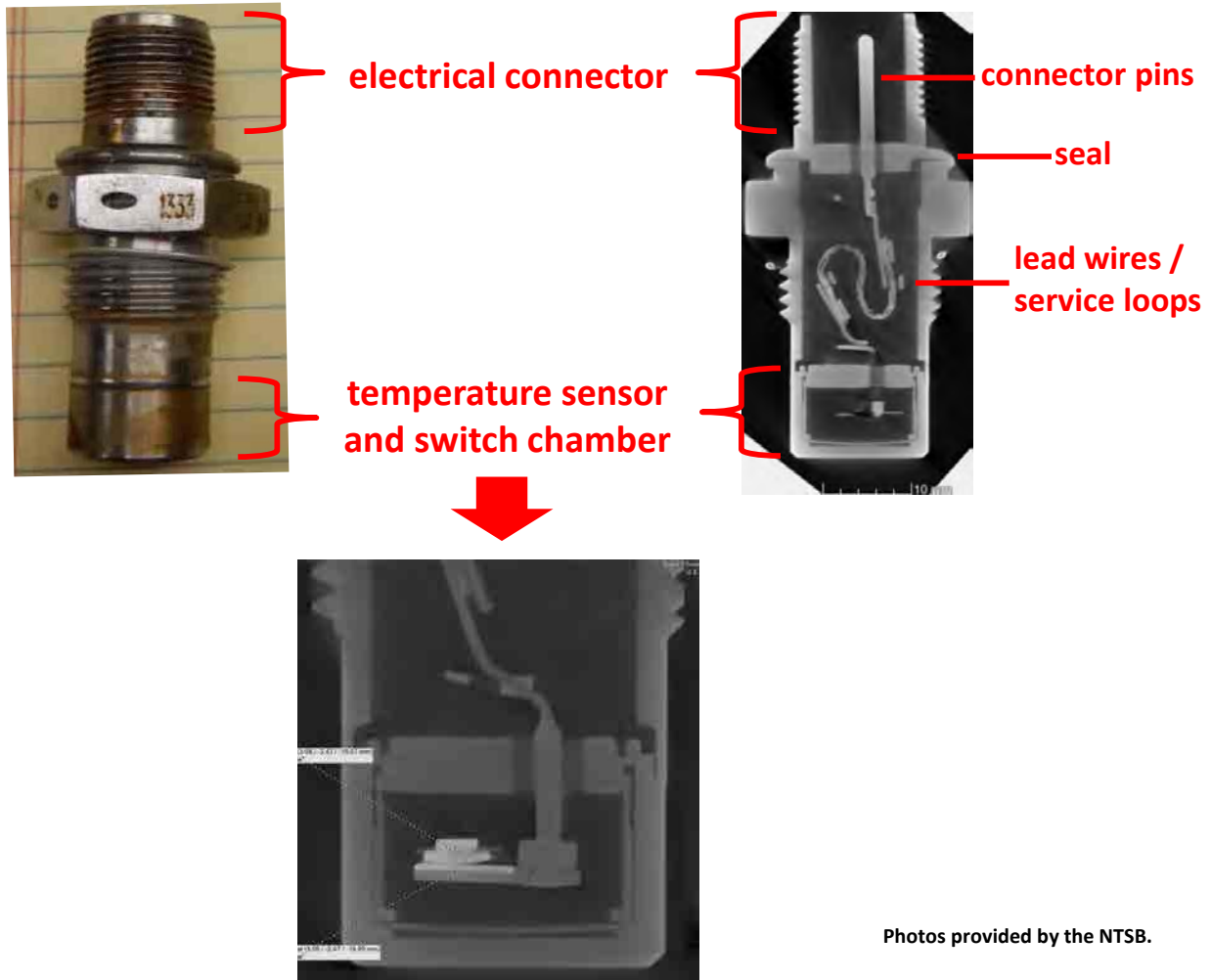


Figure 1. Photo and radiograph of the incident OTSW.

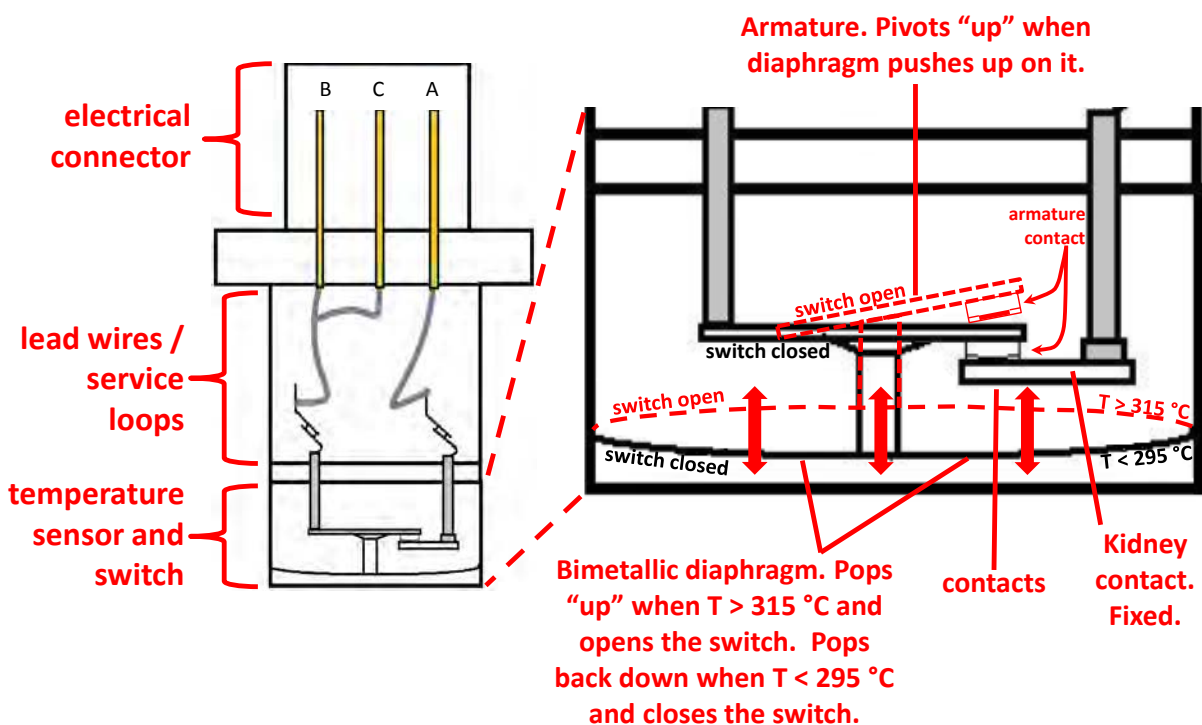


Figure 2. Diagram depicting operating principles for the OTSW.

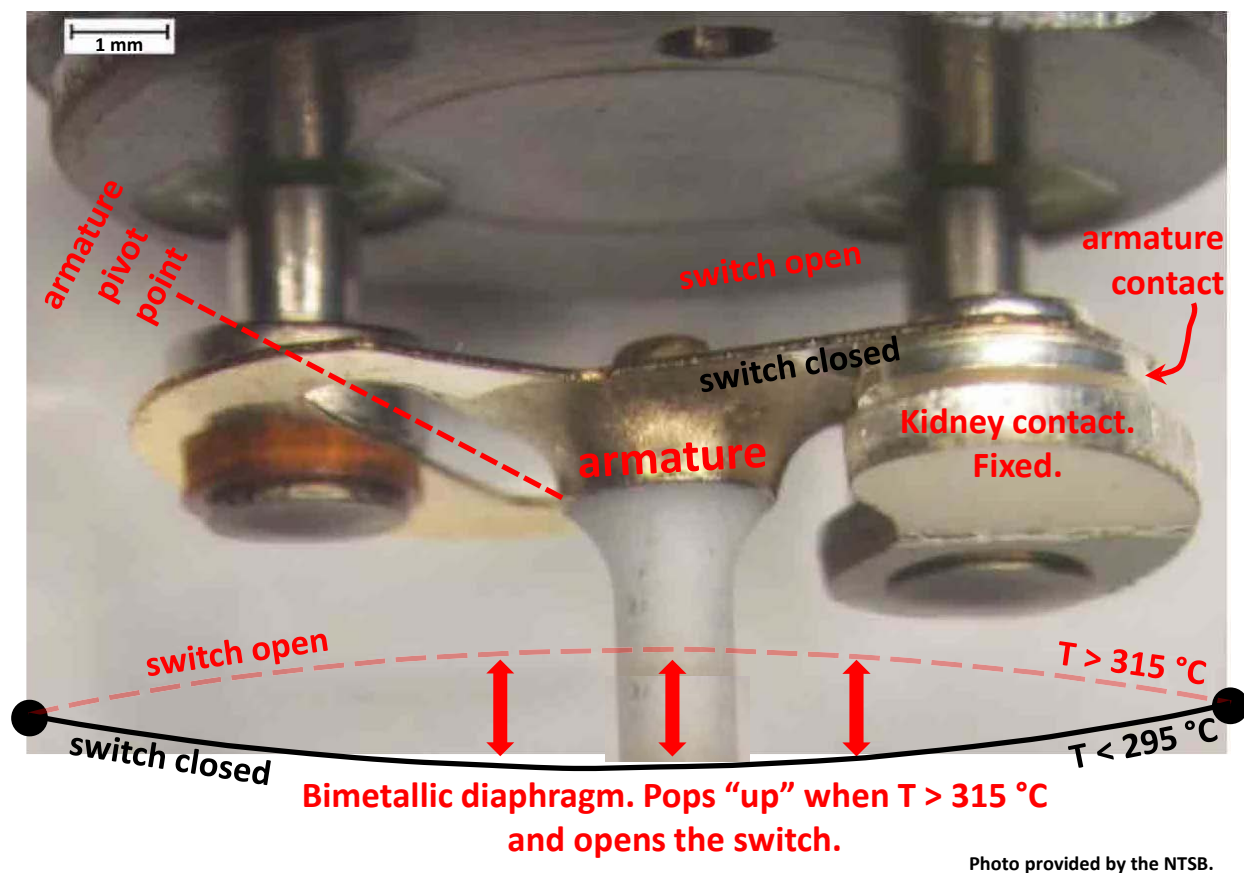


Figure 3. Photo (with annotations) of contacts in an OTSW.

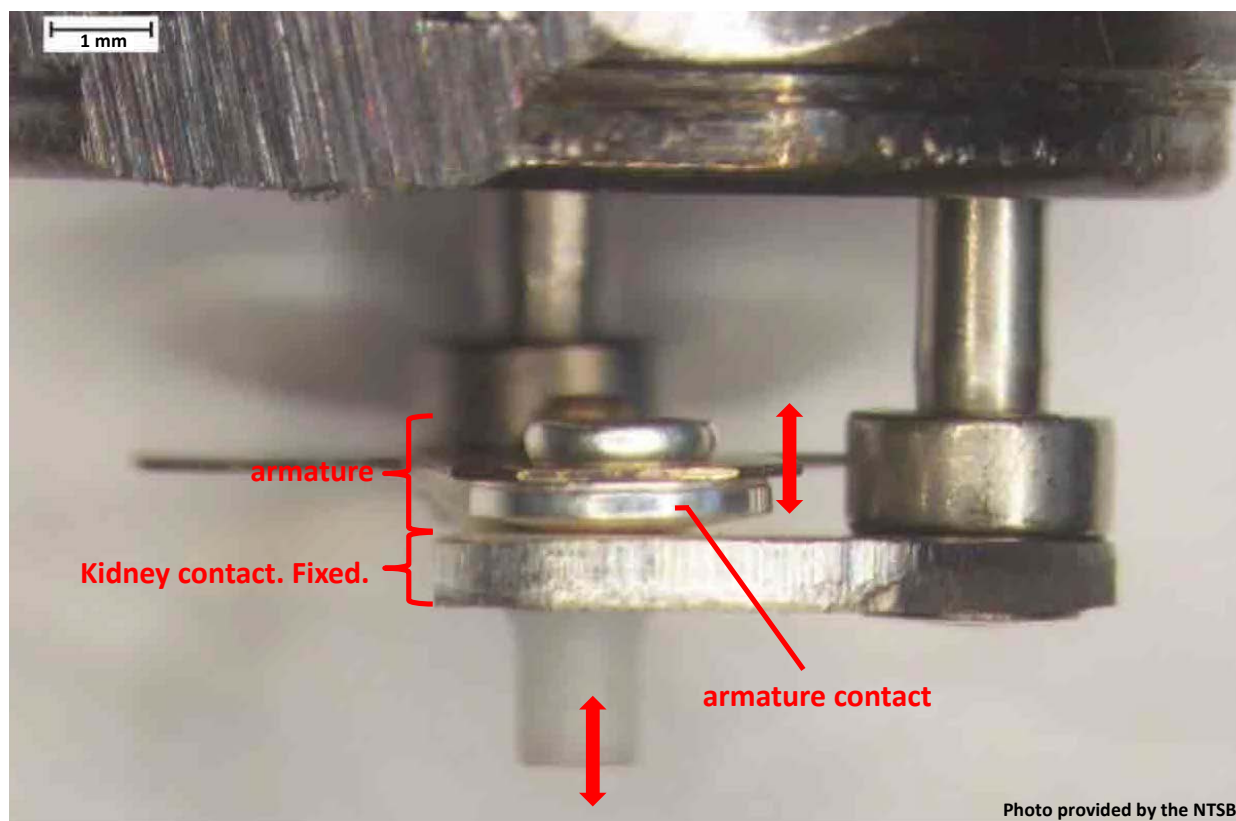


Figure 4. Photo of contacts in an OTSW.

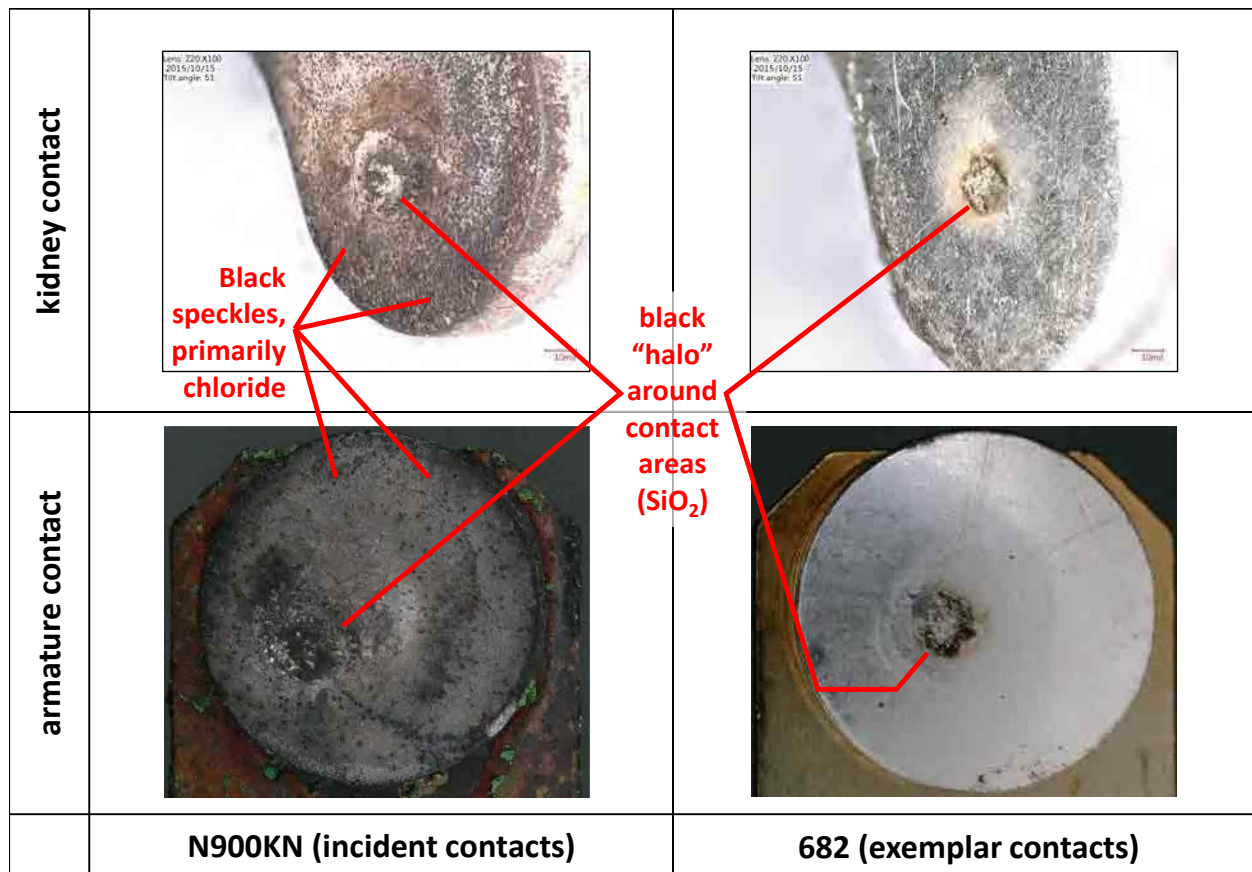


Figure 5. Digital microscope images of N900KN and 682 contacts.

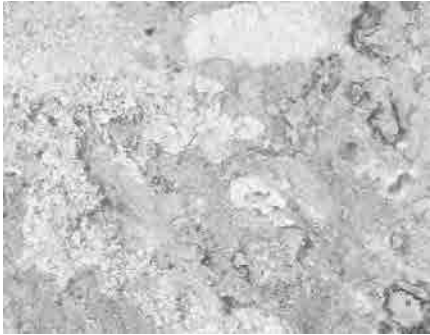
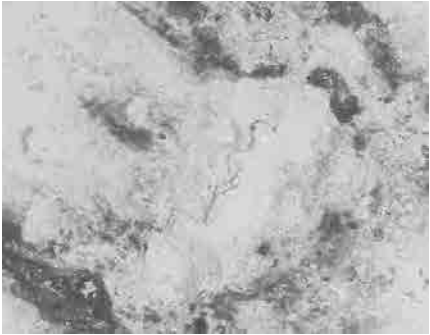
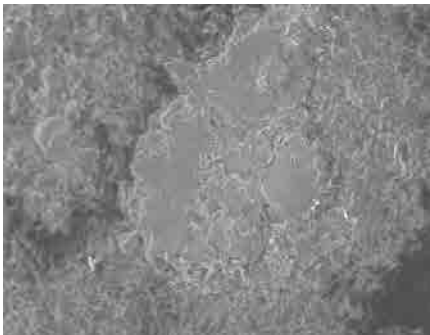
kidney contact		
armature contact		
	N900KN (incident contacts)	682 (exemplar contacts)

Figure 6. SEM images of N900KN and 682 contacts.

REVIEWED BY

[REDACTED]

BRETT A. JORDAN, Team Lead
Electrical and Electronic Materials Evaluation Team
Materials Integrity Branch
Systems Support Division
Materials and Manufacturing Directorate

PUBLICATION REVIEW: This report has been reviewed and approved.

[REDACTED]

MARY ANN PHILLIPS, Branch Chief
Materials Integrity Branch
Systems Support Division
Materials and Manufacturing Directorate

APPENDIX

Elemental Analysis of Black Halos on Contacts 682

Samples of two silver contacts identified as Armature 682 and Kidney 682 were submitted for examination of a dark “halo” ring around an area in which the two pieces had been in contact. The ring areas on each sample were very similar in appearance. The samples are referenced as Project 2774. Figure A-1 shows an image of the dark ring area as received 682 Kidney sample.



Figure A-1 – Image of Dark Ring Area on 682 Kidney Sample

The discolored area of the kidney sample was examined for elemental composition. Figure A-2 shows an overview image and elemental map of the ring area. A higher magnification image of the ring area with the corresponding elemental map is shown in Figure A-3. Both elemental maps show the ring areas to contain silicon and oxygen while areas off of the ring show only the presence of silver.

Figure A-4 shows an image and elemental map of an area of the dark material. The spectra and semi-quantitative analysis are shown in Figure A-5. The analysis shows the dark material to be composed of silicon and oxygen probably in the form of silicon dioxide (SiO_2). Silver is also detected which suggests that the residue in the ring area is very thin as the beam penetrates into the underlying silver substrate.

Figure A-6 shows an image and elemental map of an area of the adjacent substrate material in an area where the surface appears to be scratched. The spectra and semi quantitative analysis in Figure A-7 show a composition of only silver in this area.

A line scan profile across a portion of the dark ring is shown in Figure A-8. The profile shows an increase in the signal intensities for silicon and oxygen as the scan line moves across the dark ring area. A plot of the signal intensities along the scanned line is shown in Figure A-9.

The dark ring residue area was also examined by Raman spectroscopy. The Raman spectrum is shown in Figure A-10. The Raman analysis shows the characteristic peak structure of the Si-O bond at around 580 wavenumbers, which further suggests that the material is a form of silicon dioxide.

The black halo around the contact surface for the armature contact was also analyzed. It was also comprised of SiO_2 .

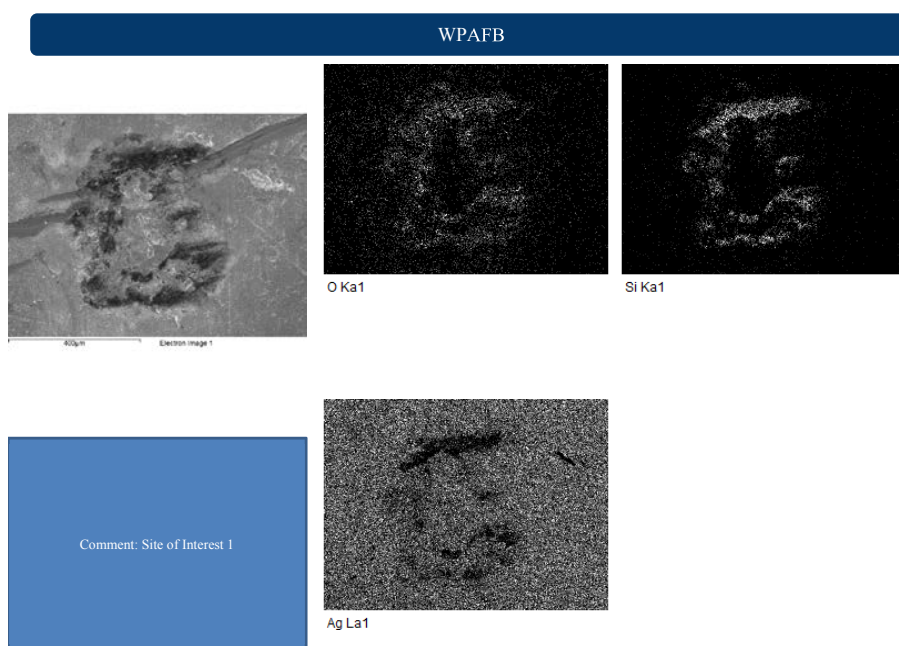


Figure A-2 – Overview Image and Elemental Map of Examined Area of Dark Ring Area on 682 Kidney Sample

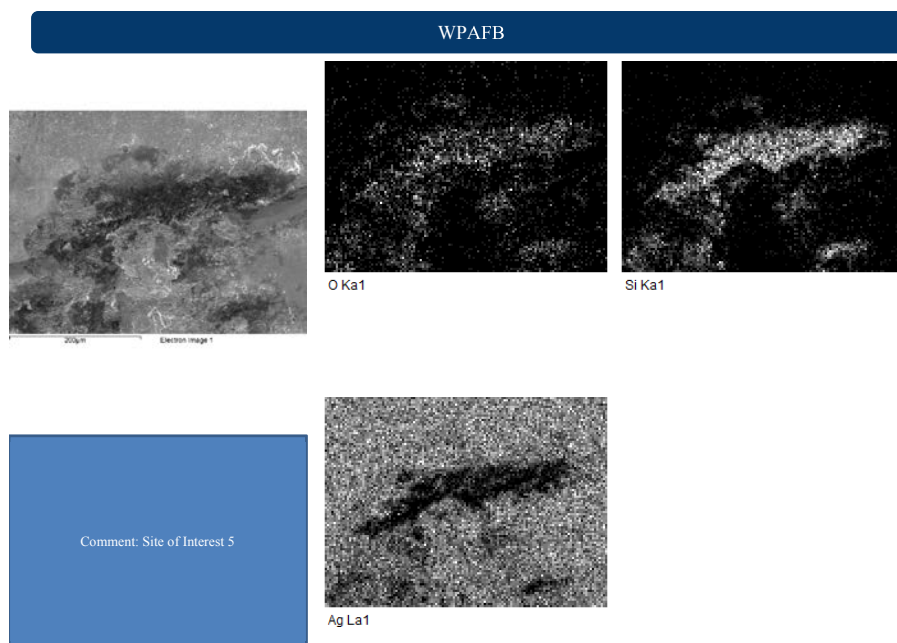


Figure A-3 – Higher Magnification Image and Elemental Map of Section of Dark Ring Area

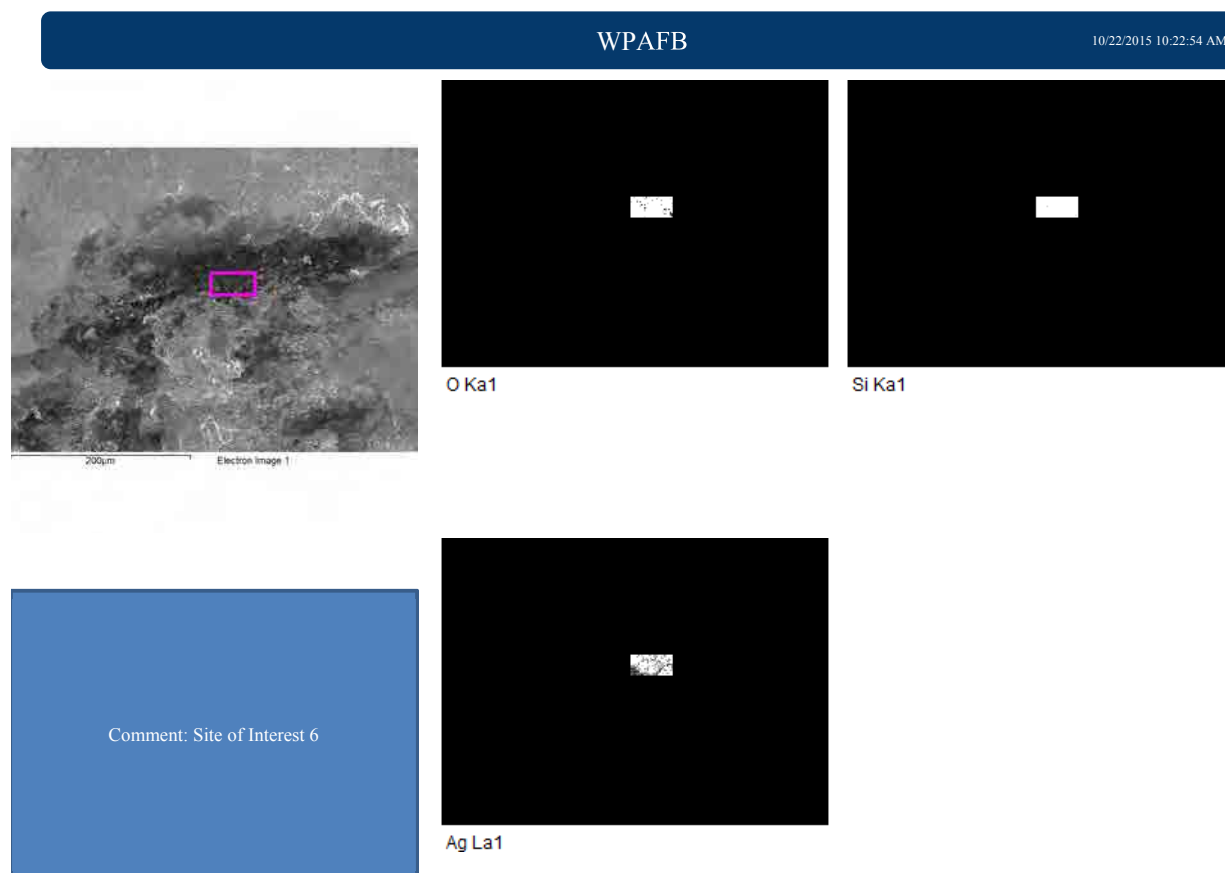


Figure A-4 – Image and Elemental Map of Examined Area of Dark Ring Residue

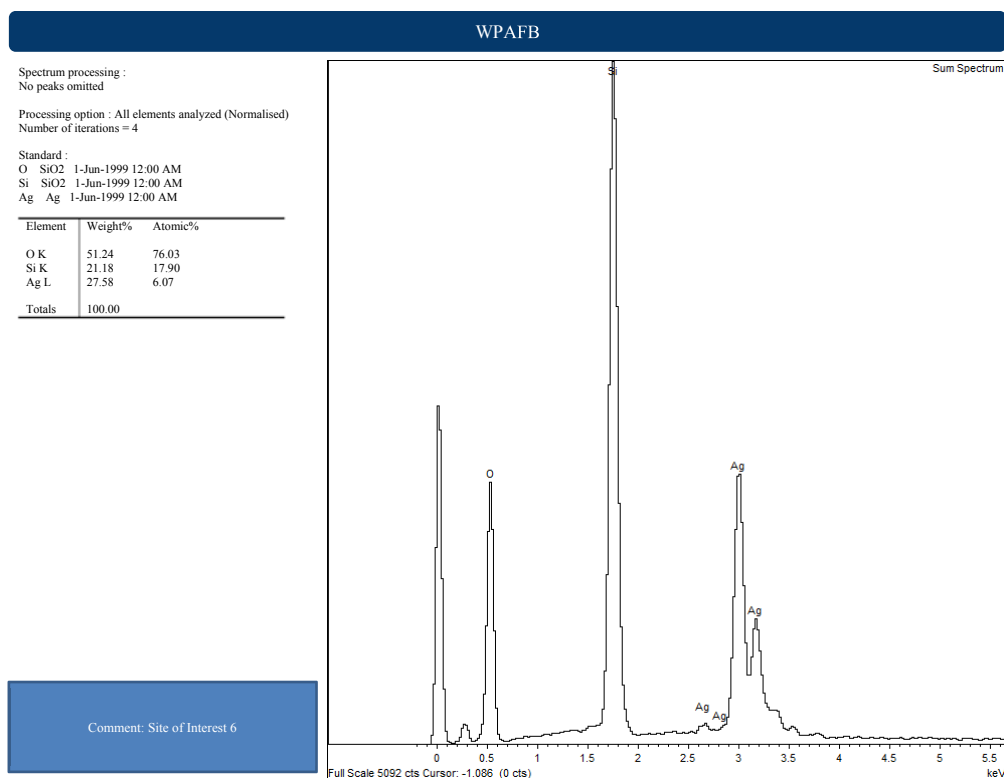


Figure A-5 – Spectra and Semi-Quantitative Analysis of Examined Area in Figure 4

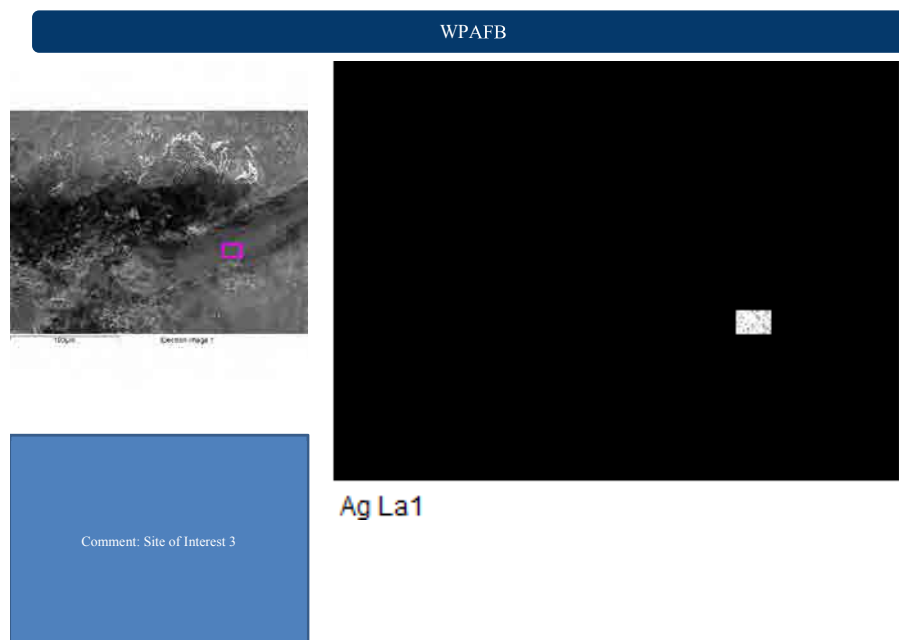


Figure A-6 – Image and Elemental Map of Examined Area of Silver Substrate

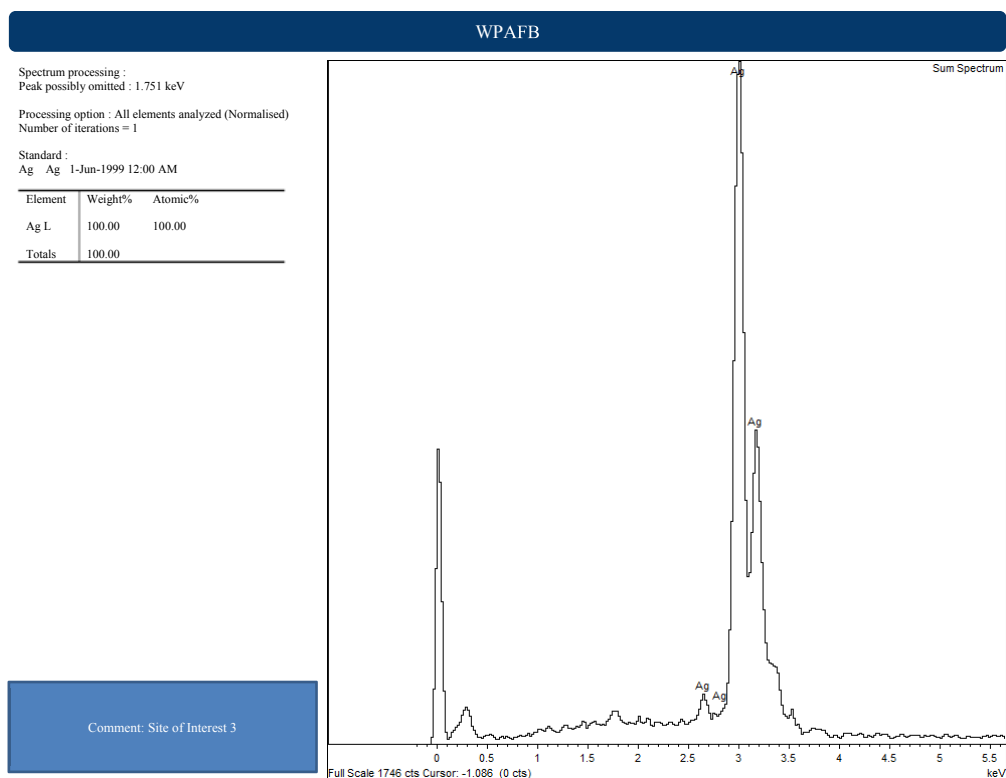


Figure A-7 - Spectra and Semi-Quantitative Analysis of Examined Area in Figure 6

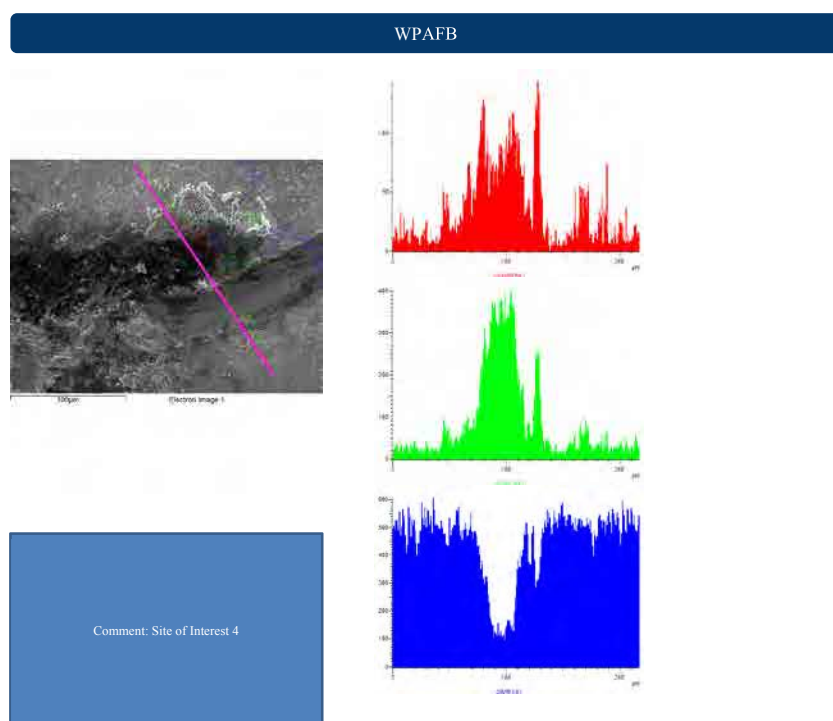


Figure A-8 – Line Scan Profile of Dark Ring Residue Area

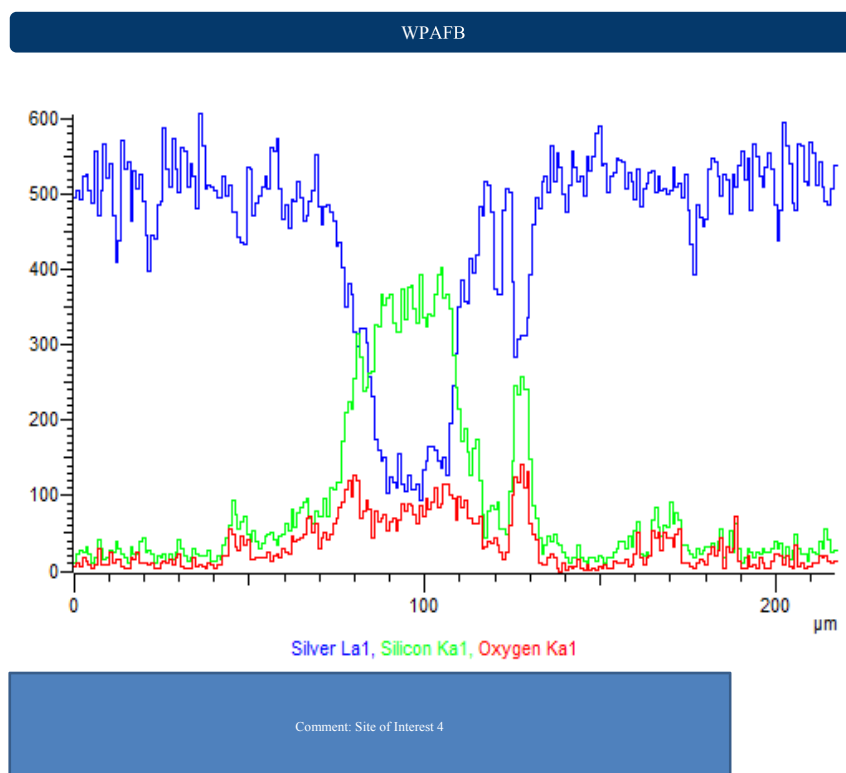


Figure A-9 – Plot of Signal Intensities Along Scanned Line in Figure 8

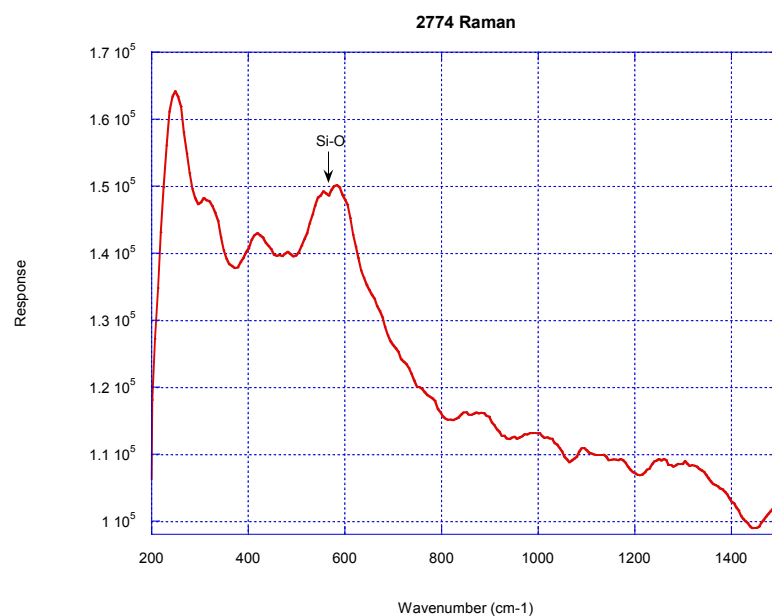


Figure A-10 – Raman Spectrum of Sample 2774 Dark Ring Material

Mary Ann Phillips, Branch Chief

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

- **Failure Analysis/Accident Investigation**
 - Structural
 - Electronic
 - Chemical
- **Consultations on**
 - Materials/Process Specifications
 - Physical and Mechanical Metallurgy
 - Materials and Component Failure Analysis
 - Electronics and Packaging
 - Bonded Repair of Metals/Composites
 - Nonmetallic Materials
 - Welding, Joining and Adhesive Bonding
 - Electrostatic Discharge Control and Process Specs/Standards
- **Nondestructive Inspection**
- **Electrostatic Discharge (ESD) Testing**
- **ESD Material Qualifications/Acceptance Testing**
- **Composites Supportability**

ATTACHMENT E

Honeywell Report

Created in response to AFRL report in Attachment D

BACKGROUND

The submitted thermal switch components were collected from various stages of the manufacturing process to identify potential points where the components could have been introduced to silicon-based contaminants.

PROBLEM STATEMENT

Evaluate the submitted components for the presence of silicon (Si).

SUMMARY/CONCLUSIONS

- Scanning electron microscope (SEM) examination of representative samples of the switch components revealed that the surfaces were generally clean and free of contaminants; however, particles rich in silicon, aluminum, and/or magnesium were detected in isolated locations. Carbon-rich debris was also detected on the surfaces in some locations.
 - Fourier transform infrared (FTIR) analyses were conducted on the thermal switch components to evaluate the surfaces for the presence of silicones. FTIR analysis of the prepared samples produced similar spectra for each component/sub-assembly. Note that silicones have strong absorption frequencies at 1260, 1100-1000 and $\sim 800\text{ cm}^{-1}$ and that none of the spectra showed any significant absorptions at these wavenumbers. The absence of absorption peaks at these wavenumbers would indicate that no silicone contaminants were present on the components analyzed by FTIR.
- See Findings.

PART NAME: Thermal Switch
PART NUMBER: 975-4150-001
PART S/N: N/A

EQUIP/ENGINE: N/A
ENGINE S/N: N/A
OPERATING TIME: Not Reported
OPERATING CYCLES: Not Reported

MATERIAL: Various
MATERIAL SPEC: Various

SUPPLIER: Not Reported
SUPPLIER P/N: Not Reported

RECEIVED DATE: 01/18/2016

COMPLETION DATE: 03/30/2016

Findings

MACROEXAMINATION

Multiple components used in the manufacture of P/N 975-4150-001 thermal switches were submitted to assess the parts for the presence of silicon-based contaminants (silicones and silicates). The submitted parts are listed in Table 1 along with P/N and quantity.

The components had been grouped and packaged by P/N prior to receiving the hardware in the Phoenix Materials Laboratory. The switch sub-assemblies (header and armature assemblies), and individual components are identified in Figure 1.

Each component was separated into low density polyethylene (LDPE) bags and numbered for traceability. Transfer of the components to individual bags, and any subsequent handling, was conducted using nitrile gloves to eliminate lab handling as a potential source of contamination.

SCANNING ELECTRON MICROSCOPE (SEM) EXAMINATION

Samples from each group of components were selected for evaluation in the SEM. The components examined are listed in Table 1.

HEADER ASSEMBLY 1

SEM examination of Header Assembly 1 revealed that the surfaces of the components were generally clean and free of contaminants; however, backscattered electron (BSE) and elemental dot map analyses detected some silicon-rich particles embedded in the surface of the fixed contact in isolated locations (Figure 2).

Examination of Header Assembly 1 also revealed that the glass between the terminal pins and header was silicon-rich with lesser concentrations of sodium, potassium, barium, and aluminum (Figure 3). Traces of iron were also detected in the glass.

ARMATURE ASSEMBLY 1

BSE and energy dispersive X-ray (EDX) analysis of Armature Assembly 1 detected aluminum and silicon-rich oxides in the surface of the armature (Figure 4). The grit-like material was embedded in the plating in an isolated location.

ARMATURE 1

No evidence of silicon-based contaminants was detected in the surfaces of Armature 1 by BSE/EDX analysis (not shown).

CONTACTS 1 AND 2

BSE/EDX analysis of the flat side of Contact 1 detected silicon-rich particles embedded in the surface in some locations (Figure 5). The particles were generally confined to damaged areas in the silver plating.

Examination of the stem side of Contact 2 revealed embedded particles in the plated surface (Figure 6). The particles were comprised of silicon, aluminum, and/or magnesium-rich oxides. The oxide particles were generally confined to scores/scratches in the plating.

BSE/EDX analysis of Contacts 1 and 2 also detected carbon-rich deposits on the surfaces (Figures 5B and 6A; spectra not shown).

BUTTONS 1 AND 2

No notable silicon-rich contaminants were detected on Buttons 1 and 2 by BSE/EDX analysis (not shown).

SPACER 1

BSE/EDX analysis of Spacer 1 detected aluminum-rich oxide particles and carbon debris embedded in the surface (Figures 7A-B; spectra not shown). No evidence of silicon-rich contaminants were detected.

CASE 1

BSE/EDX analysis of Case 1 detected carbon-rich debris on the surface (Figures 7C-D; spectra not shown). No evidence of a silicon-based contaminant was detected.

FOURIER INFRARED (FTIR) EXAMINATION

FTIR analyses were conducted on the thermal switch components to evaluate the surfaces for the presence of silicones. Samples were prepared for analysis through extraction using a hexane solvent to remove any silicones that may have been present on the surfaces. The sub-assemblies/components evaluated are listed in Table 1.

FTIR analysis of the prepared samples produced similar spectra for each component/sub-assembly (Figures 8-14). Note that silicones have strong absorption frequencies at 1260, 1100-1000 and $\sim 800\text{ cm}^{-1}$ and that none of the spectra showed any significant absorptions at these wavenumbers. The absence of absorption peaks at these wavenumbers would indicate that no silicone contaminants were present on the components analyzed by FTIR.

Distinct absorption peaks were present at ~ 3350 , ~ 3200 , and $\sim 1650\text{ cm}^{-1}$ in each of the spectra generated from analysis of the thermal switch

components. IR absorption at these wavenumbers was suggestive of an amide compound, most similar to Eurcamide (Figure 15). The exact source of the amide-based contaminant was not definitively determined.

Table 1. Part Information

Part Name
Case
Spacer
Ceramic Button
Armature
Contact
Header assembly
Armature Assembly

Quantity	Components Examined in the SEM	Components Examined by FTIR
2	Case 1	Case 2
5	Spacer 1	Spacers 2 and 3
8	Buttons 1 and 2	Buttons 3 and 4
8	Armature 1	Armatures 2 and 3
14	Contacts 1 and 2	Contacts 3 and 4
5	Header Assy. 1	Header Assy's 2 and 3
8	Armature Assy. 1	Armature Assy's 2 and 3

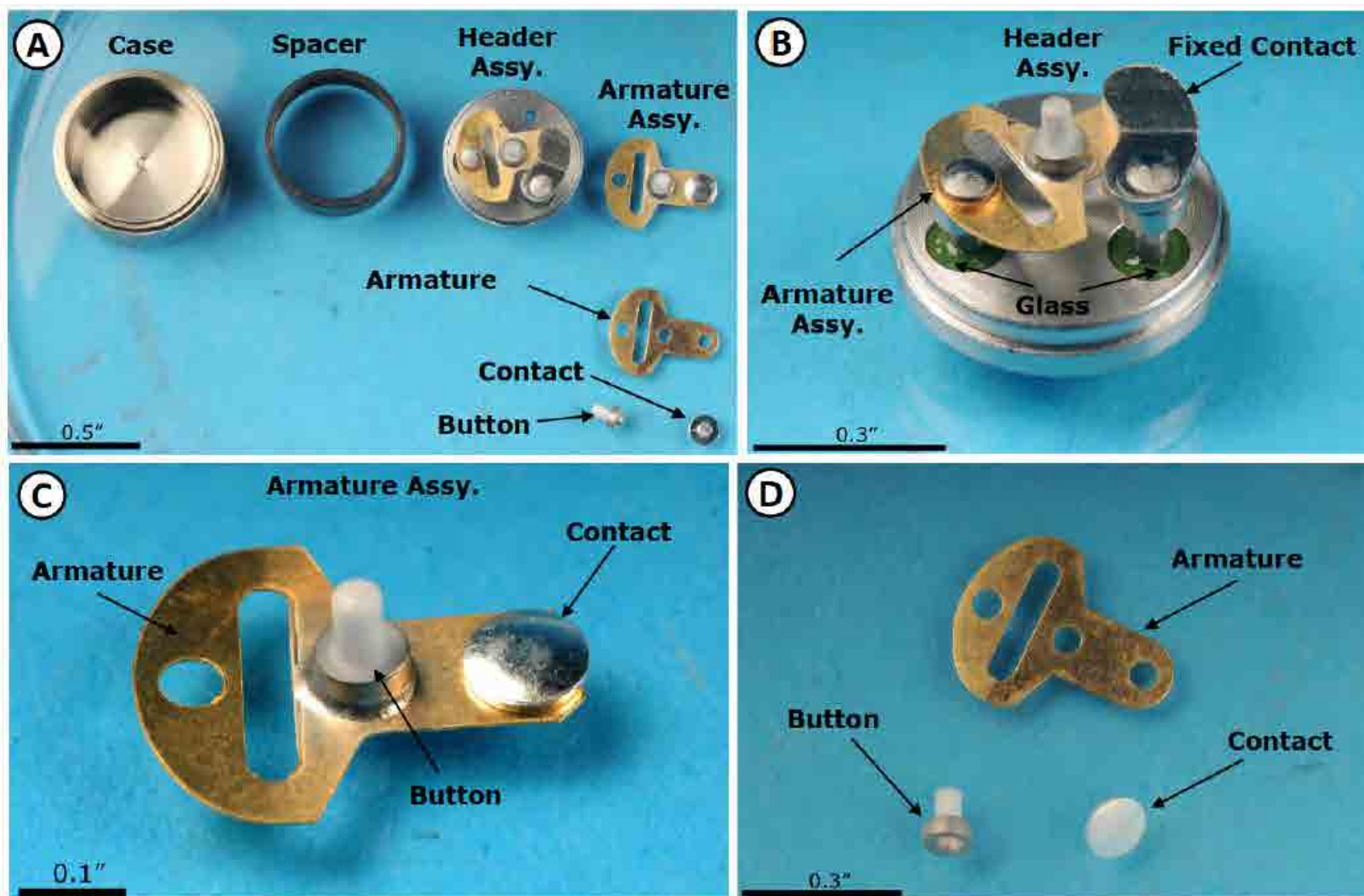


Figure 1.

(A) Overall and (B-D) close-up photos identifying the various components of the thermal switch. Refer to Table 1 for the quantity of parts submitted.

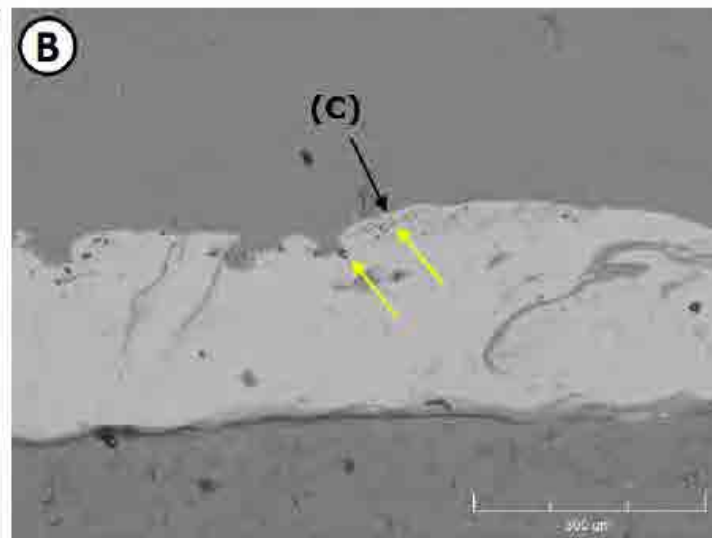
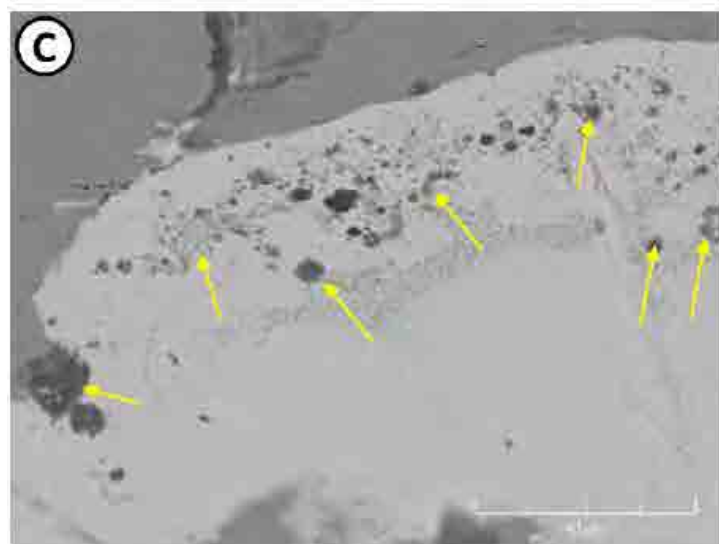
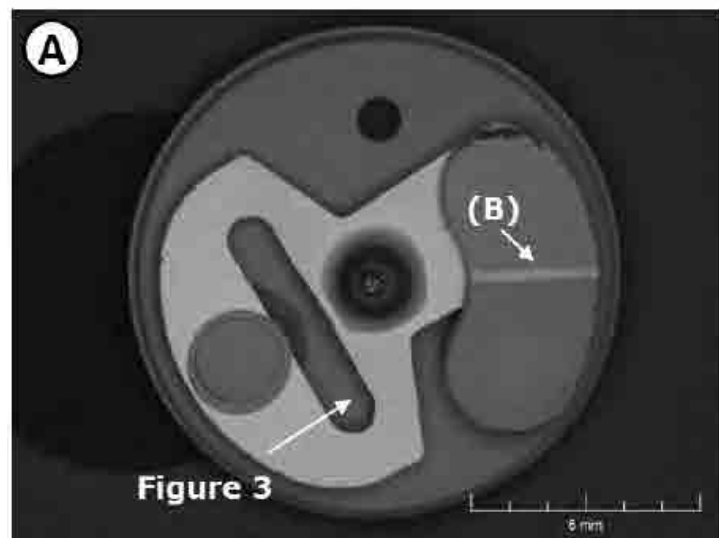


Figure 2.

(A-C) Backscattered electron (BSE) SEM images of Header Assembly 1 showing the location where silicon-rich deposits (yellow arrows in (B) and (C)) were detected in the silver plating on the surface of the fixed contact.

(D) Elemental dot map produced for silicon in the area shown in (C). Note that the light (white) areas in (D) indicate the presence of silicon on the surface. A higher magnification image of the area indicated in (A) is shown in Figure 3.

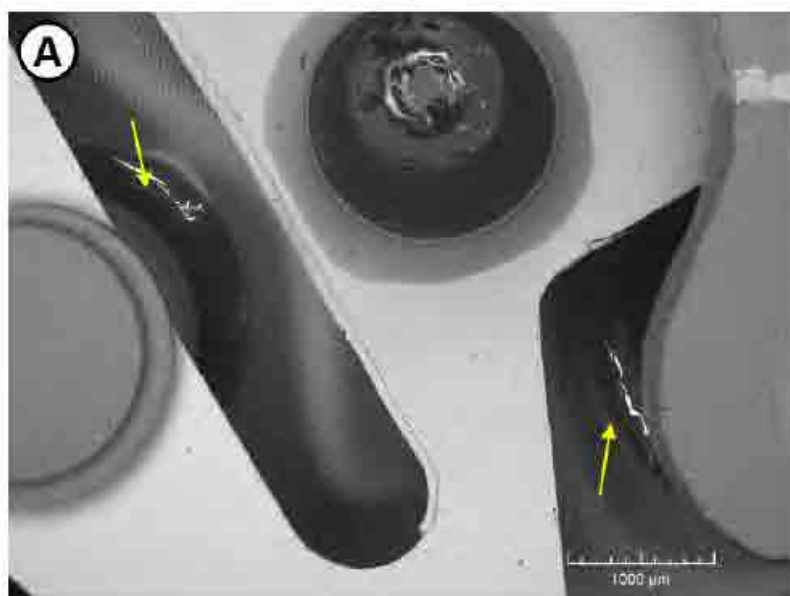
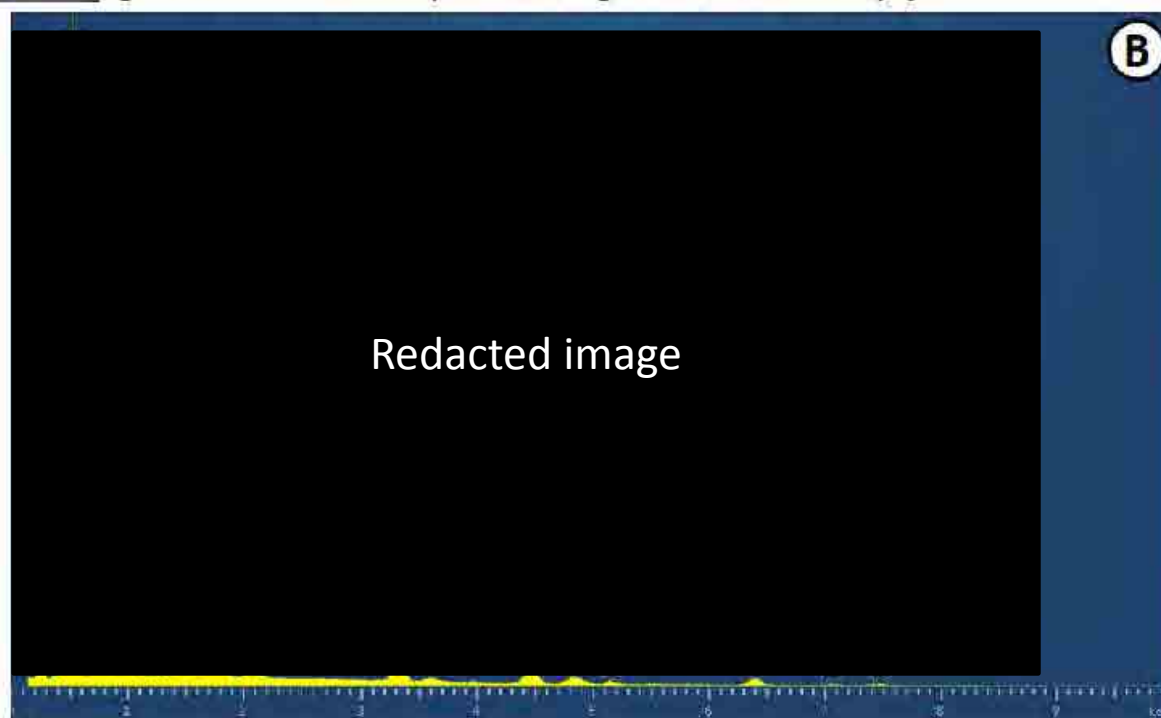


Figure 3.

(A) BSE SEM image identifying the silicon-rich glass (yellow arrows) detected between the header assembly and the base of the header posts (reference Figure 2). (B) EDX spectrum generated from analysis of the glass identified in (A).



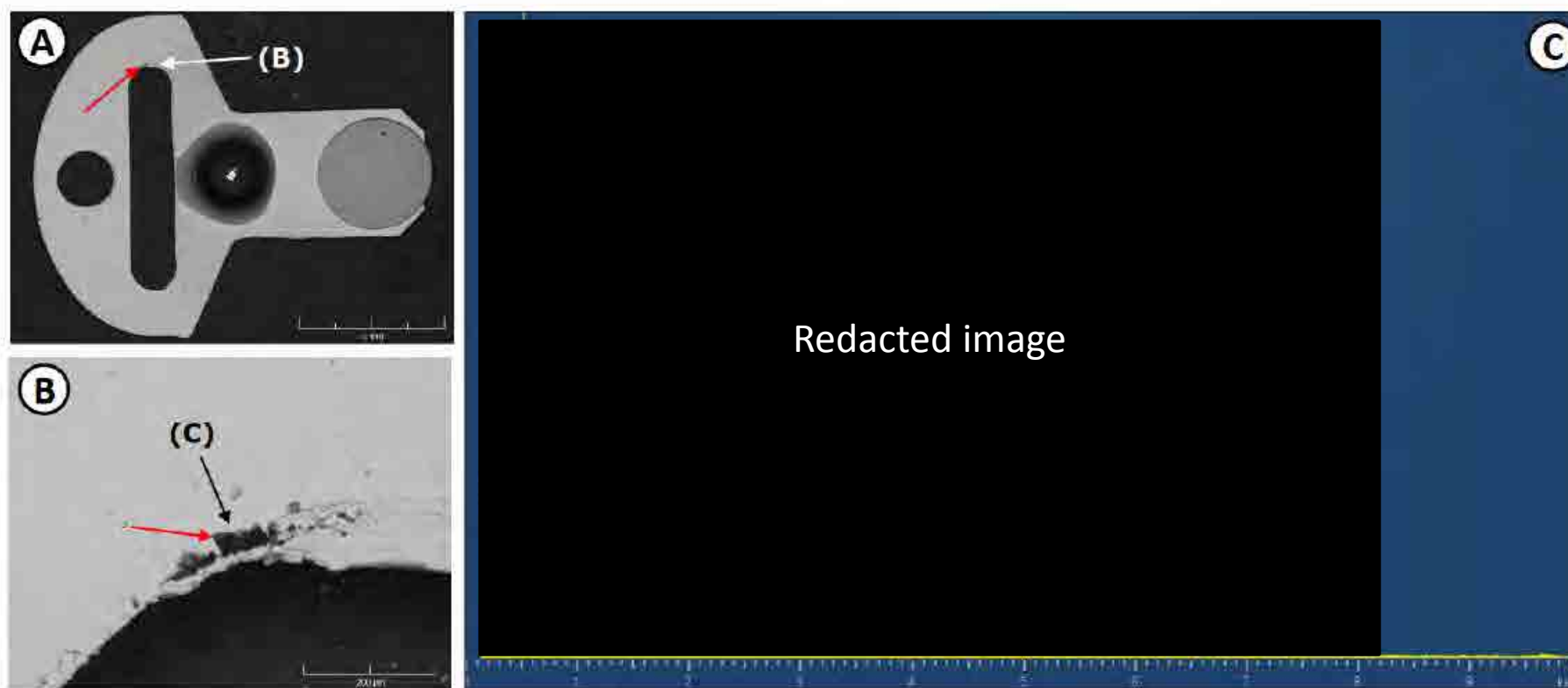


Figure 4.

(A-B) BSE SEM images showing the location of some silicon and aluminum-rich oxides (red arrows) detected in the surface of Armature Assembly 1. (C) EDX spectrum generated from analysis of the oxides indicated in (B).

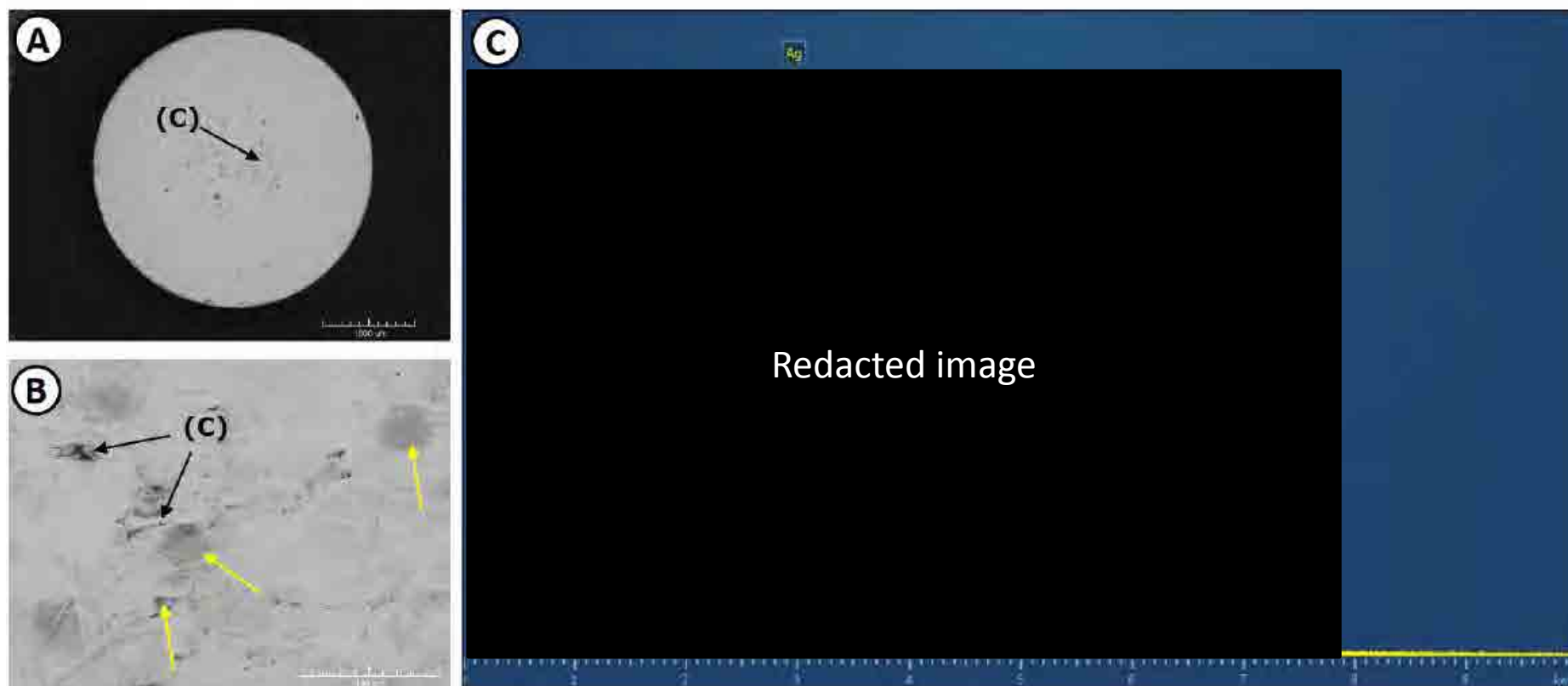


Figure 5.

(A-B) BSE SEM images showing the location of some silicon-rich material detected in the surface of Contact 1. The yellow arrows in (B) point to carbon-rich deposits detected on the surface. (C) EDX spectrum generated from analysis of the silicon-rich material indicated in (B).

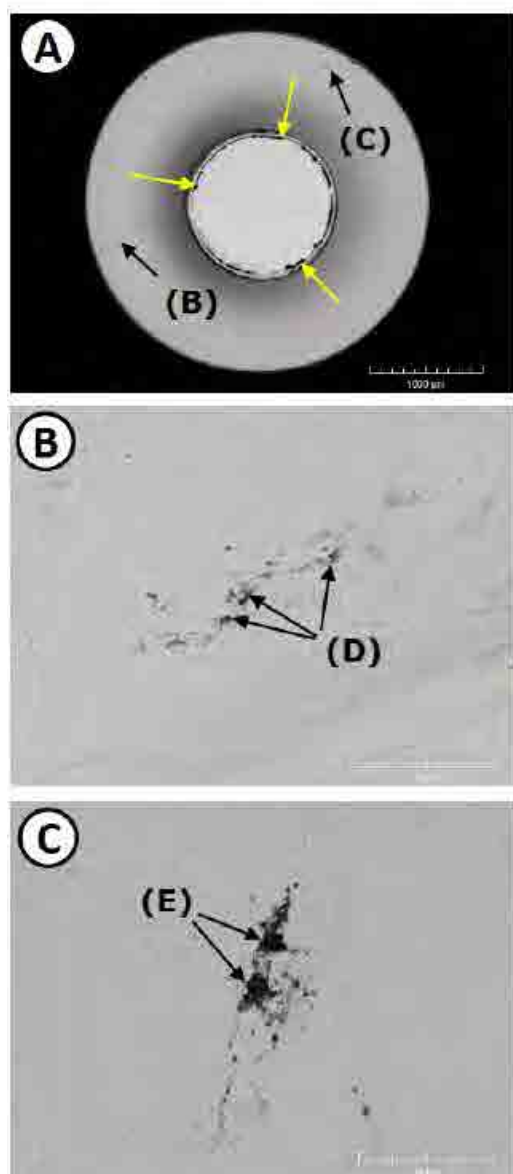
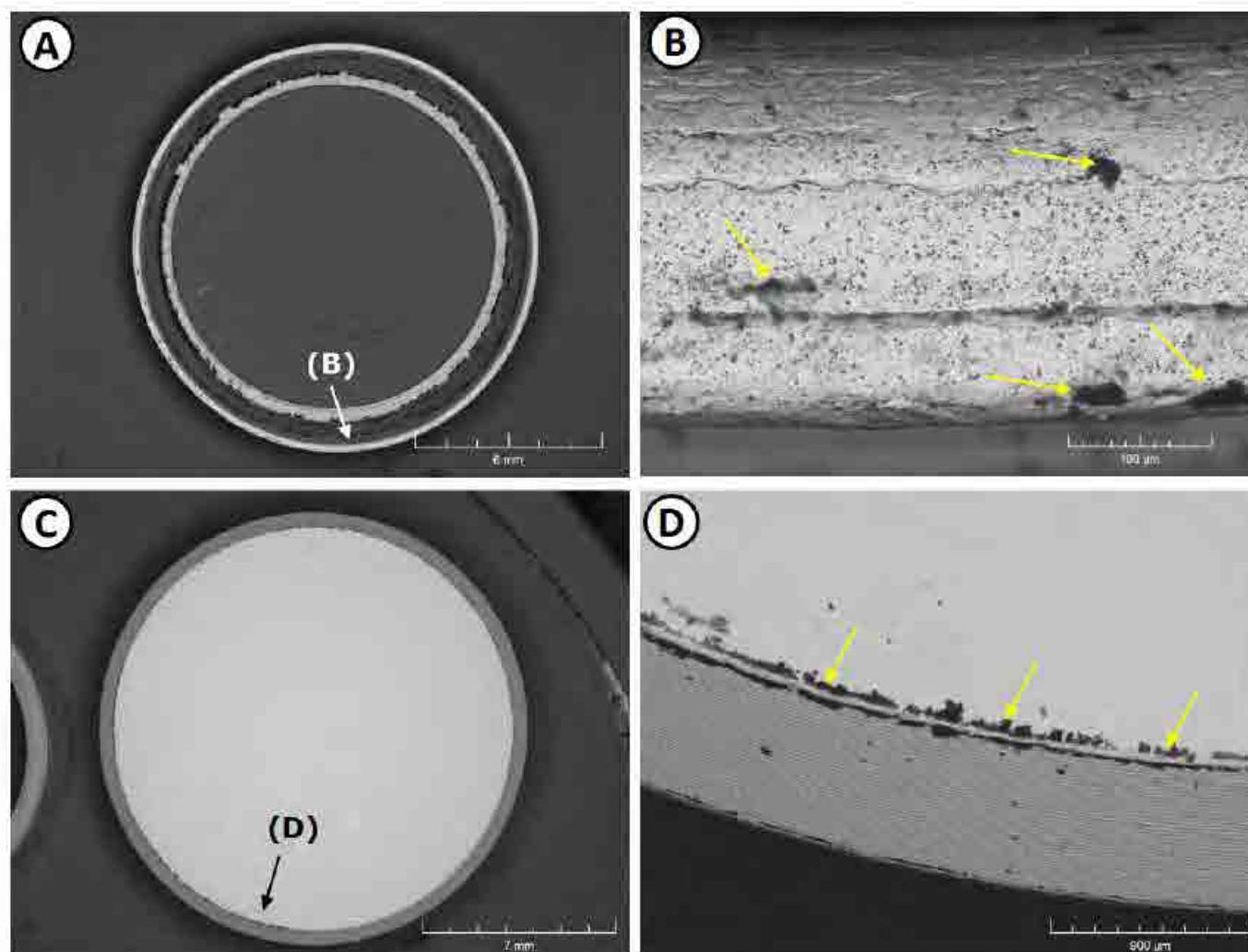


Figure 6. (A-C) BSE SEM images showing the location of some silicon, aluminum, and/or magnesium-rich material detected in the surface of Contact 2 (stem side). The yellow arrows in (A) point to carbon-rich deposits detected on the surface. (D-E) EDX spectra generated from analysis of the material indicated in (B) and (C), respectively.

**Figure 7.**

BSE SEM images showing representative areas of (A and B) Spacer 1 and (C and D) Case 1. The yellow arrows in (B) and (D) point to some of the carbon-rich deposits detected on the surfaces of both components. The small, dark embedded particles in the surface of Spacer 1 in (B) were aluminum-rich oxides.

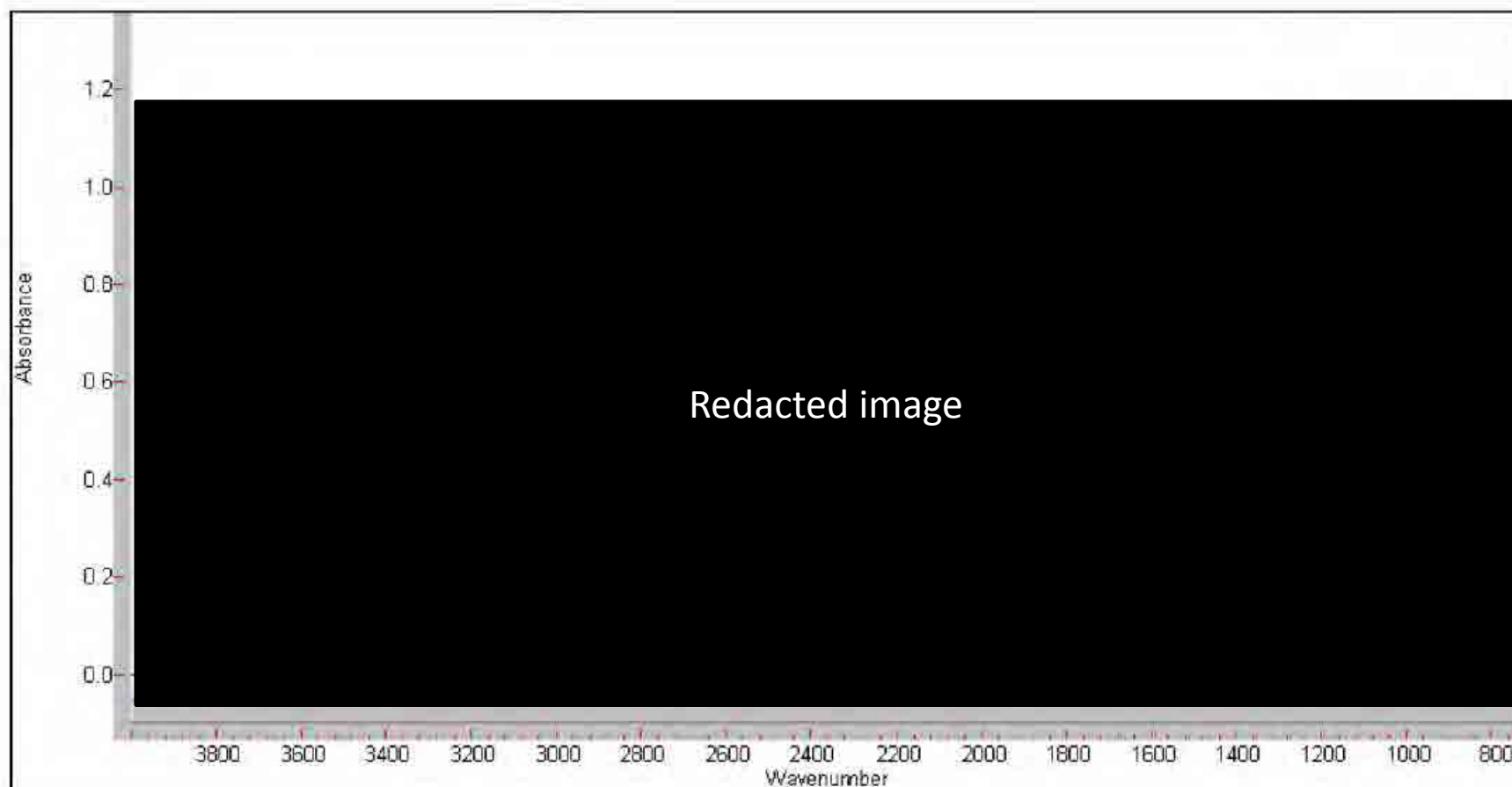


Figure 8.

FTIR spectrum generated from analysis of the sample prepared from Header Assembly 2. Note the absence of absorbance bands at 1260, 1100-1000, and $\sim 800\text{ cm}^{-1}$ (red arrows). A similar spectrum was produced from the sample prepared from Header Assembly 3 (not shown).

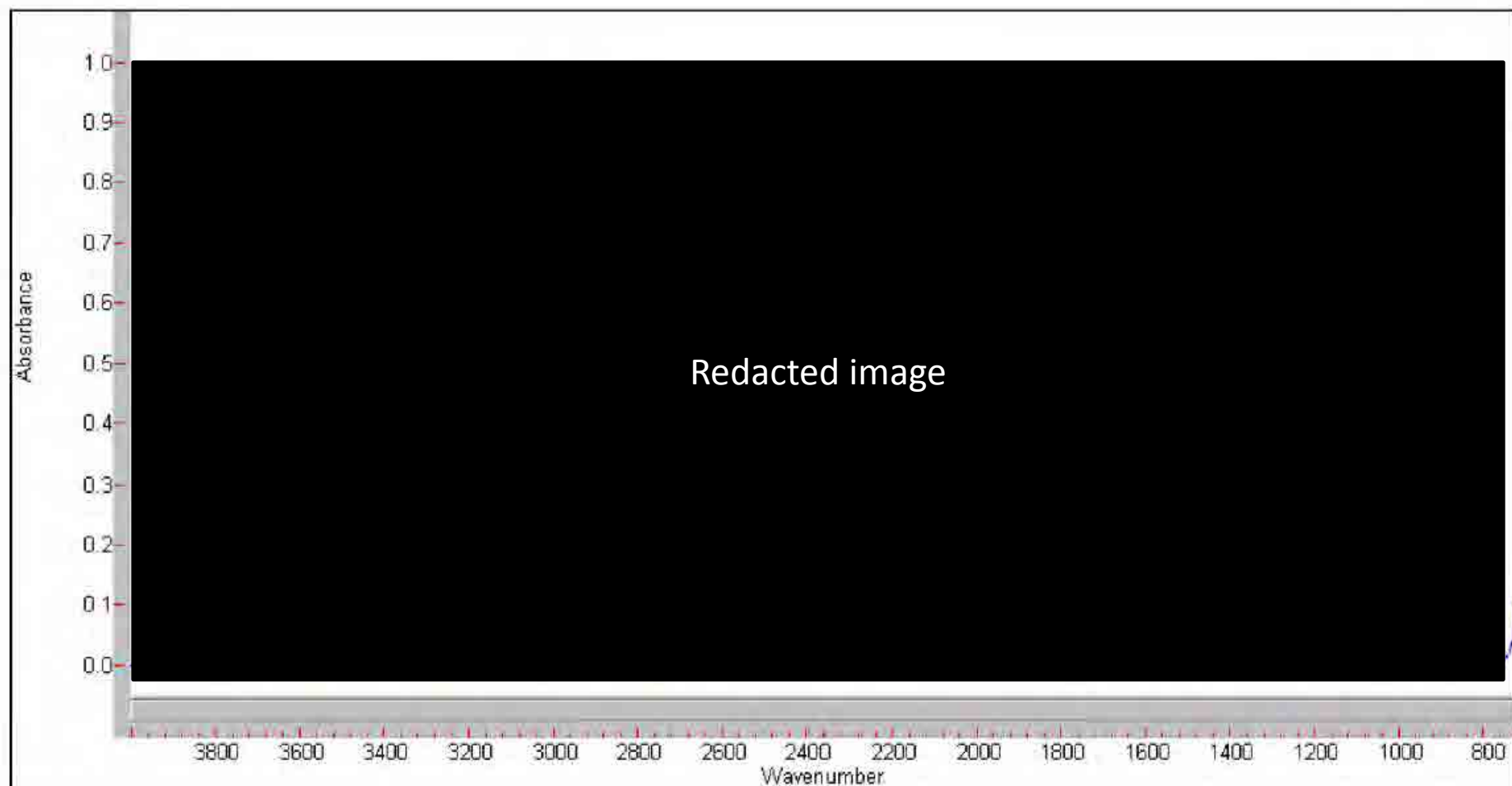


Figure 9.

FTIR spectrum generated from analysis of the sample prepared from Case 2. Note the absence of absorbance bands at 1260, 1100-1000, and $\sim 800 \text{ cm}^{-1}$ (red arrows).

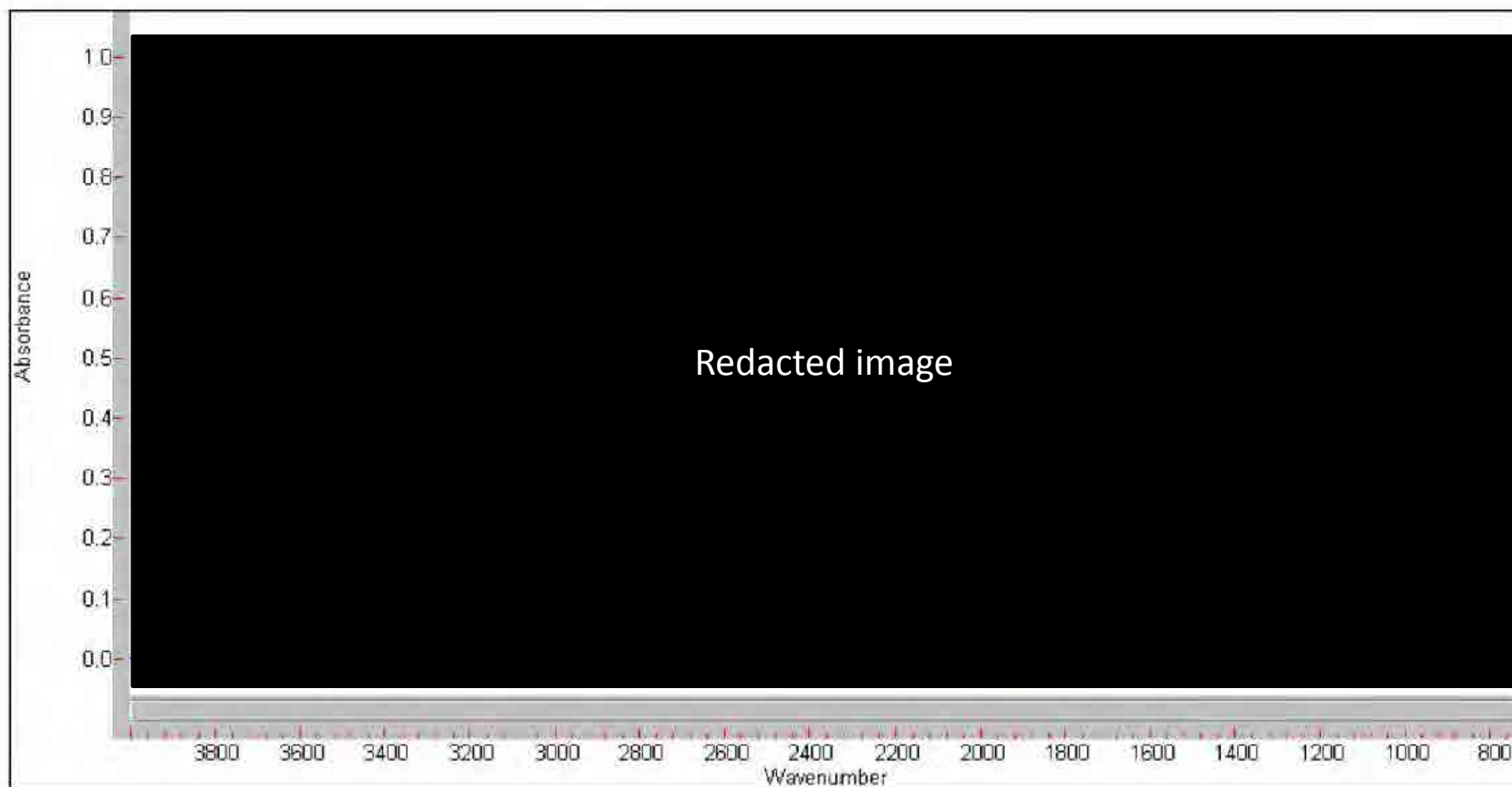


Figure 10.

FTIR spectrum generated from analysis of the sample prepared from Spacer 2. Note the absence of absorbance bands at 1260, 1100-1000, and $\sim 800\text{ cm}^{-1}$ (red arrows). A similar spectrum was produced from the sample prepared from Spacer 3 (not shown).

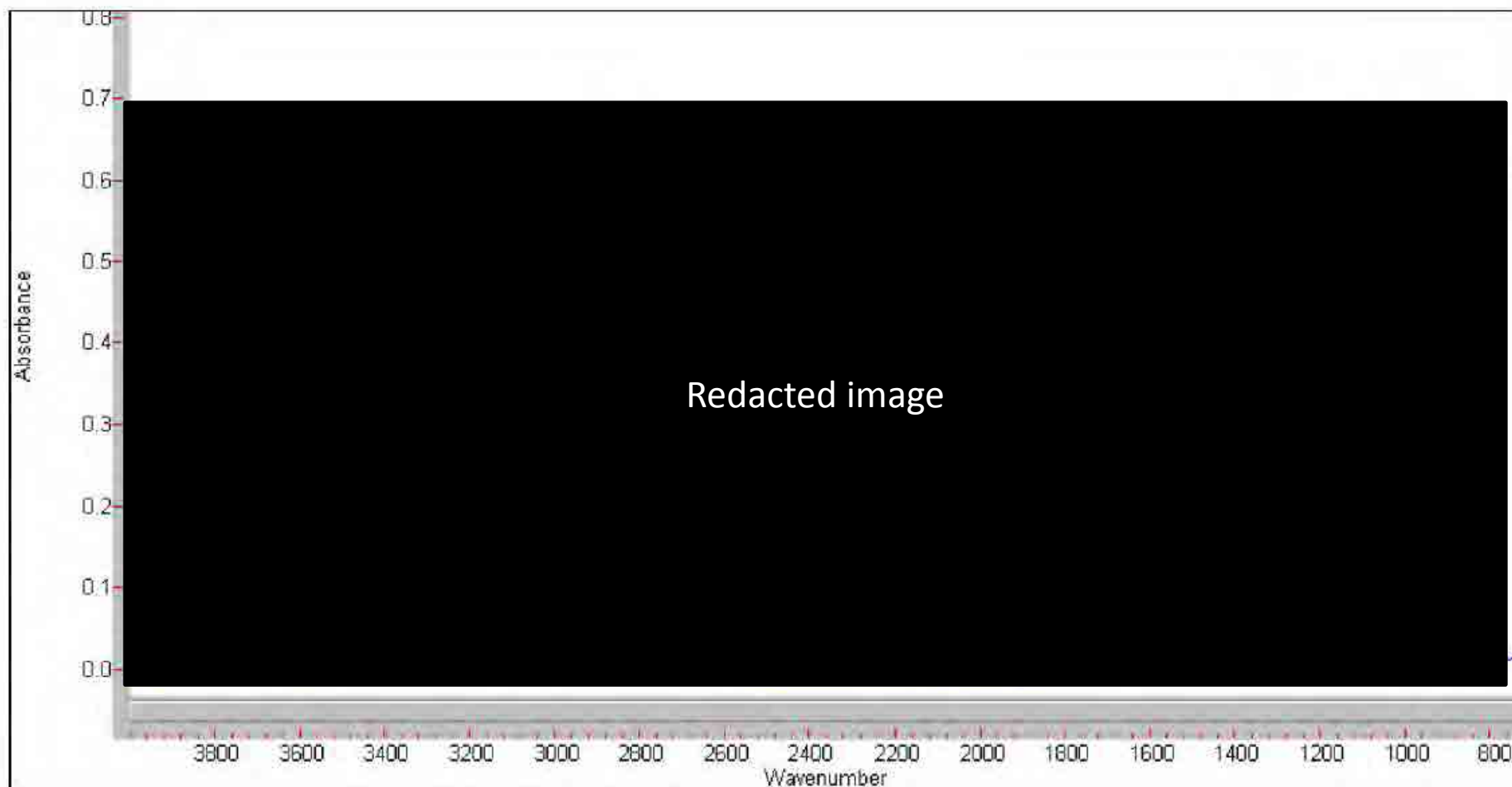


Figure 11.

FTIR spectrum generated from analysis of the sample prepared from Armature Assembly 2. Note the absence of absorbance bands at 1260, 1100-1000, and ~ 800 cm^{-1} (red arrows). A similar spectrum was produced from the sample prepared from Armature Assembly 3 (not shown).

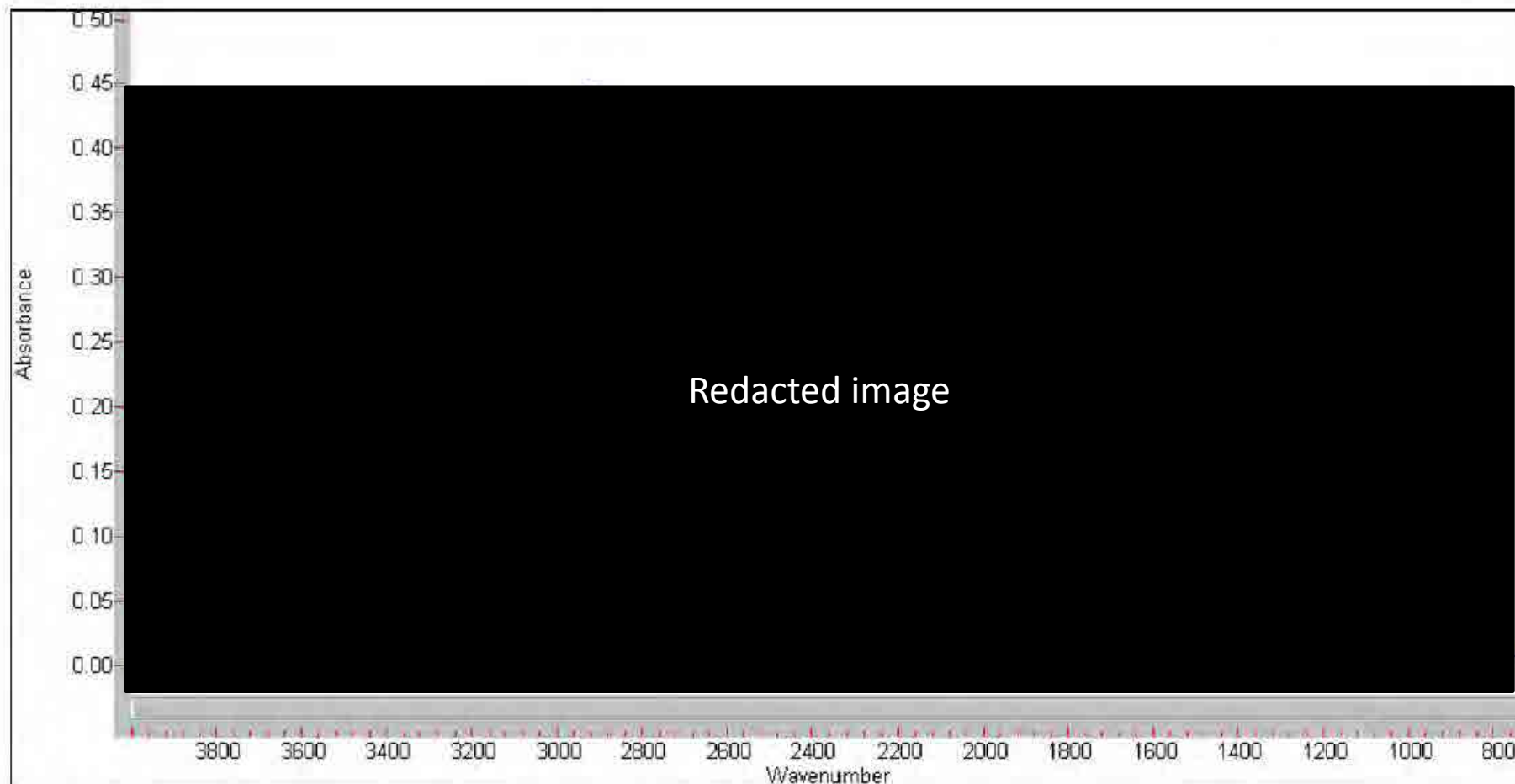


Figure 12.

FTIR spectrum generated from analysis of the sample prepared from Armature 2. Note the absence of absorbance bands at 1260, 1100-1000, and $\sim 800 \text{ cm}^{-1}$ (red arrows). A similar spectrum was produced from the sample prepared from Armature 3 (not shown).

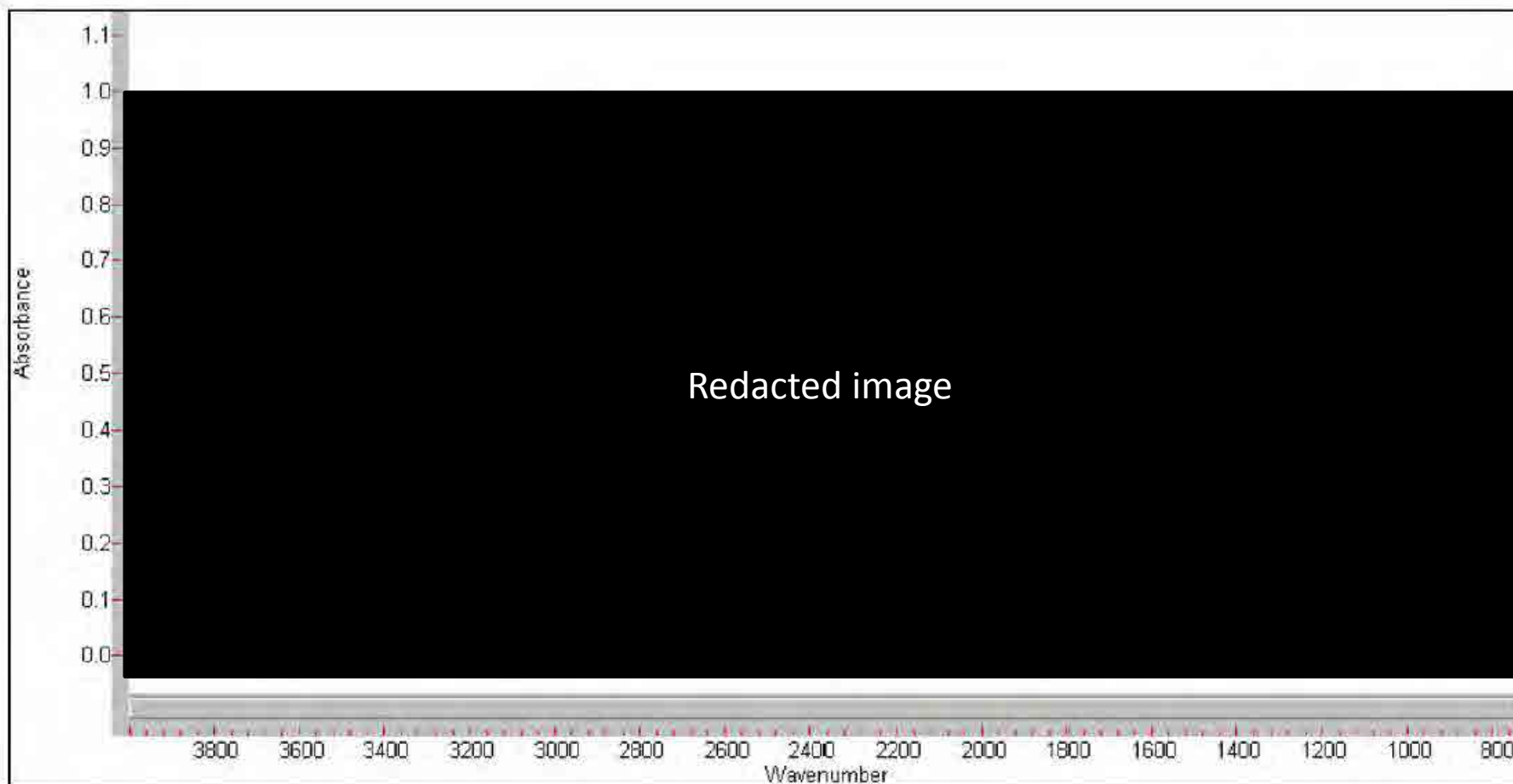


Figure 13.

FTIR spectrum generated from analysis of the sample prepared from Contact 4. Note the absence of absorbance bands at 1260, 1100-1000, and $\sim 800 \text{ cm}^{-1}$ (red arrows). A similar spectrum was produced from the sample prepared from Contact 3 (not shown).

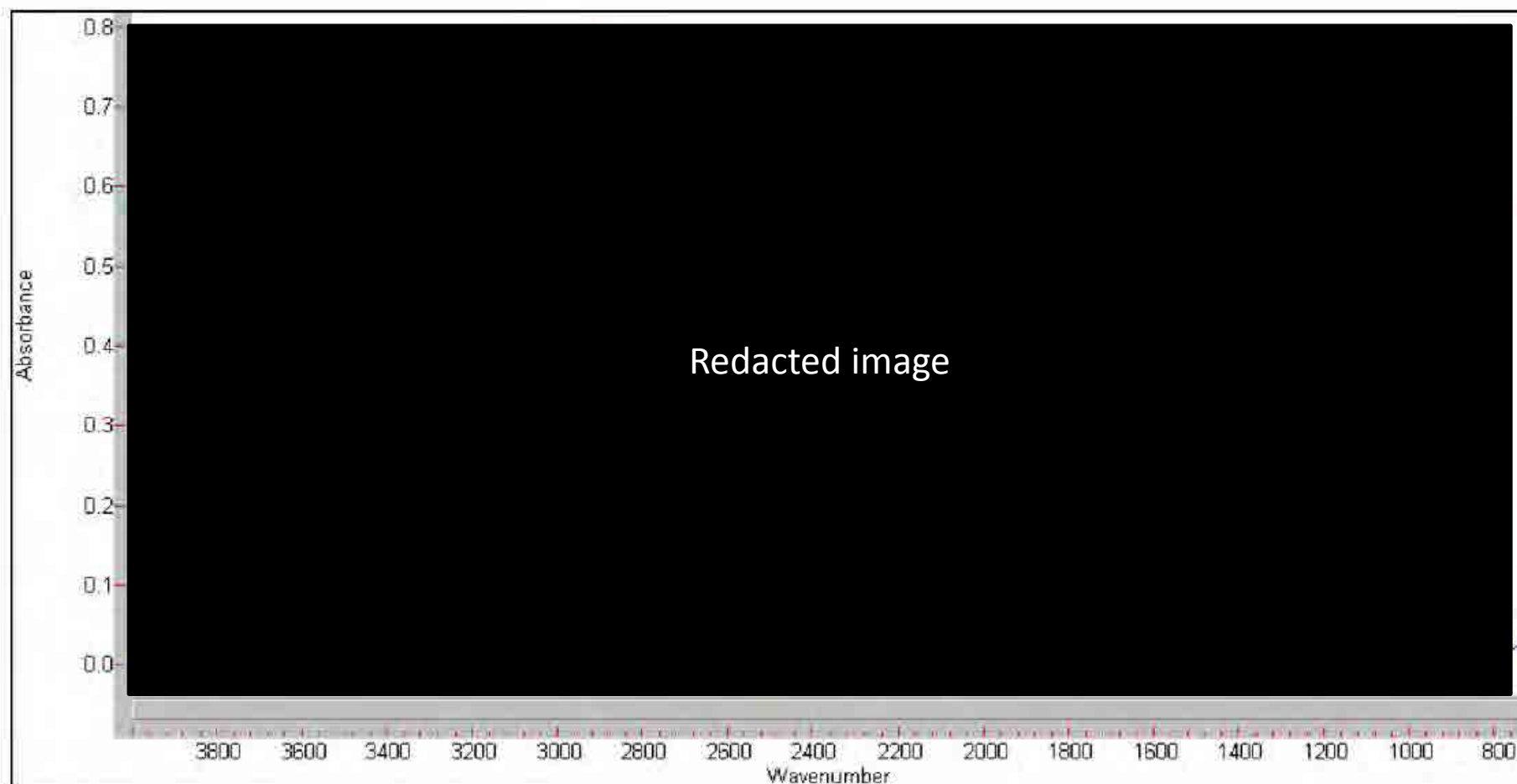


Figure 14.

FTIR spectrum generated from analysis of the sample prepared from Button 3. Note the absence of absorbance bands at 1260, 1100-1000, and ~ 800 cm^{-1} (red arrows). A similar spectrum was produced from the sample prepared from Button 4 (not shown).

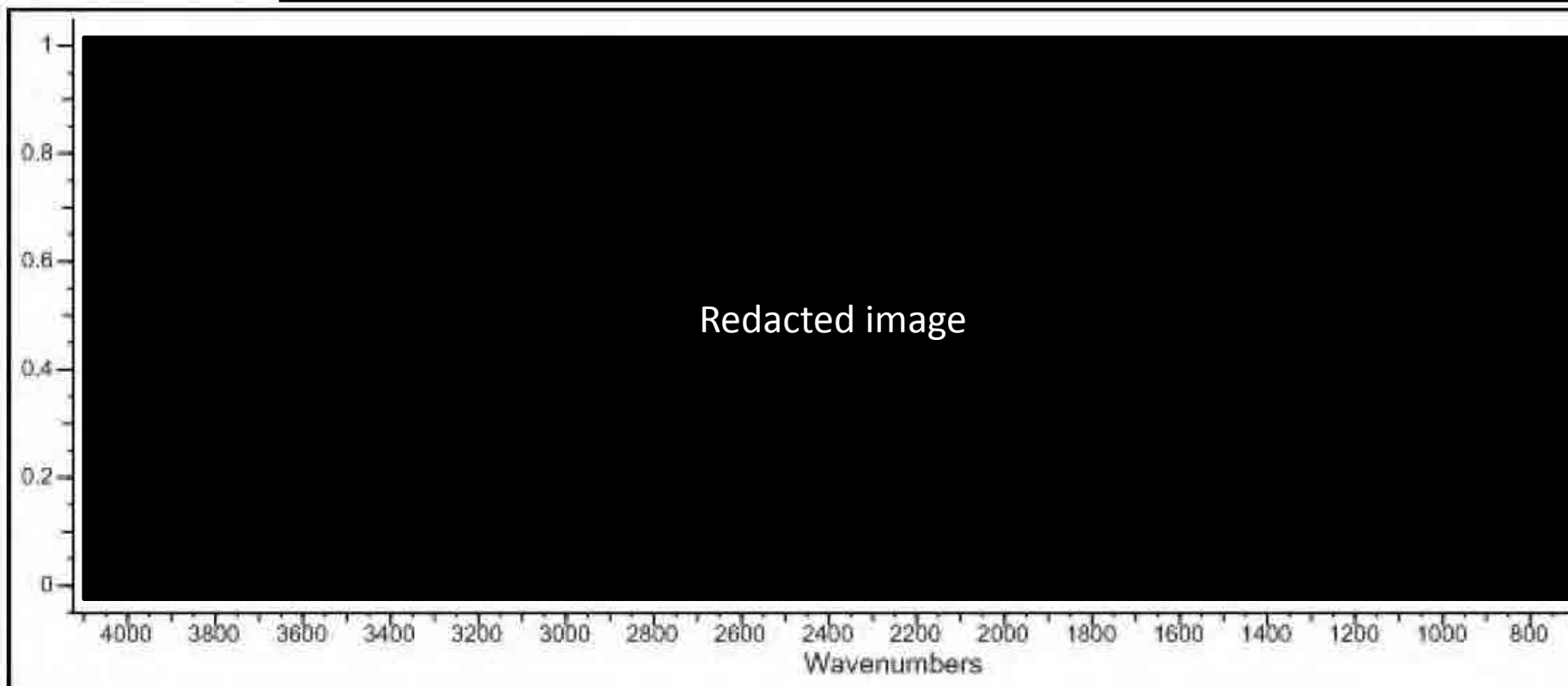


Figure 15.

FTIR spectrum produced for Armature Assembly 3 (black) with an overlay spectrum (red) for the nearest match from the FTIR library. The nearest match spectrum was for Erucamide, an amide-based slip agent. Note that the spectra produced for each of the switch components analyzed (reference Figures 8-14) exhibited similar absorption peaks at ~ 3350 , ~ 3200 , and ~ 1650 cm^{-1} and within the fingerprint region (region between ~ 1500 and 500 cm^{-1}), which indicated that the amide-based contaminant was present on each of the components.

ATTACHMENT F

ACF50 Data Sheet for material sprayed on parts after
removal from water in sealed containers

Product Specifications

ACF-50 PERFORMANCE QUALIFIED Mil-C-81309E Amd 3, Type II

Characteristics	Requirements	Test Para.	Found
- Minimum flash point	60°C (140°F)	4.7.1	Conforms (175F)
- Synthetic Sea Water-Sulfurous Acid Spray	Type II: No visible corrosion of carbon steel after 2 cycles.	4.7.2	Conforms
- Synthetic Sea Water displacement	No visible corrosion.	4.7.3	Conforms
- Removability	Not more than 3 cycles to remove.	4.7.4	Conforms
- Abrasives	Non present	4.7.5	Conforms
- Maximum film thickness	Type II: 0.0005 inches	4.7.6	Conforms
- Sprayability	Sprayable	4.7.7	Conforms
- Corrosivity	No visible pitting, etching or dark discoloration. No weight change (milligram/cm2) greater than 0.5 for magnesium, cadmium, and zinc nor greater than 0.2 for aluminum, copper, and brass.	4.7.8	Conforms
- Staining	No visible evidence of staining or other deleterious effects.	4.7.9	Conforms
- Minimum dielectric breakdown	25,000 volts	4.7.10	Conforms 38,000 volts
- Mixability of compounds	No evidence of separation	4.7.11	Conforms
- Lubricity of compounds	Less than 0.20	4.7.12	Conforms
- Effect on electric components	No Significant change in capacitance, dissipation factor and conductance of coil forms and capacitors. For coils no significant change in the Q and amount of capacitance to resonate the coil. No significant change in the resistance of resistors. A change greater than 1/2 the allowed tolerance of the component shall be considered as significant.	4.7.13	Conforms
- Effect on electric connectors	No significant increase in resistance between connected pins or decrease in resistance between adjacent pins.	4.7.14	Conforms

ADDITIONAL ACF-50 TEST DATA

TEST IDENTITY	TEST METHOD	RESULTS
BMS 3-23E Table I	ASTM D93	Pass
-Flash Point	MIL-C-1617D	Pass
-Sprayability	MIL-C-1617D	Pass
-Low-Temperature Adhesion	ASTM D1644	Pass
-Nonvolatile Content		Pass
-Detectability		Pass
-Removability		Pass
-Storage Stability		Pass
-Drying Time		Pass
-Compatibility with Cadmium		
Douglas Aircraft CSD #1		
- Painted Surfaces	ASTM F 502	Conforms
- Residue Surfaces	ASTM F 485	Conforms
- Sandwich Corrosion Test		Conforms
- Stress Cracking Acrylic Plastics	ASTM F 484	Conforms
- Immersion Corrosion Test	ASTM F 483	Conforms
- Cadmium Removal Test	ASTM F 1111	Conforms
Douglas Aircraft DMS 2150		
- Film Characteristic	ASTM D-56	Conforms
- Product Composition	ASTM D-1644A	Conforms
- Appearance	ASTM D-445	Conforms
- Toxicity	ASTM B-117	Conforms
- Flash Point		Conforms
- Nonvolatile Content		Conforms
- Viscosity		Conforms
- Salt Fog Exposure		Conforms
- Water Displacement		Conforms
- Removability		Conforms
- Storage Stability		Conforms
Table II		
-Water Displacement Ability	MIL-C-1617D	
-Viscosity		
-Corrosion Inhibiting Characteristics	FED-STD 791 (ASTM G 34)	Pass
-Functional Penetration Test		
Airbus Industrie TN A 007.10138		
Corrosion Resistance To:		
Turco Toilet Fluid, Orange Juice, Coke, Coffee, De-Icing Fluid		
3:4-1:2-1:4, 5% NaOH, 5% HCl, 5% HNO ₃ , 10% CH ₃ COOH, 45% Ethanol		
Volatile Organic Content		
-California Air Quality Compliant	ASTM 2369	>166.9g/L
Misc.		
-Humidity Resistance	AMS 3066B	Conforms
-Hydrogen Embrittlement	ASTM F 519	Conforms
-Polyimide Insulated Wire	MIL-C-87937B	Conforms

ACF-50 has endorsements or approvals from 23 airframe OEM's and meets industry anti-corrosion performance requirements.



Attachment G

Daher-Socata Service Bulletin SB70-226



SOCATA SAS
Direction des Services
65921 TARBES CEDEX 9
FRANCE

TELEPHONE : 33 (0)5 62.41.73.00
TELEFAX : 33 (0)5 62.41.76.54

SERVICE BULLETIN

TBM AIRCRAFT

SB 70-226

21

ATA No.

RECOMMENDED

The technical content of this document is approved
under the authority of DOA No. EASA.21J.013

SUBJECT : GAS CONTROLLER UPGRADE

REFERENCE : MODIFICATION SHEET No. MOD70-0454-21

EFFECTIVITY : TBM 700 aircraft S/N 434 to 1097

NOTE :

For the other aircraft, the modification MOD70-0454-21 is applied at the factory.

PURPOSE :

A. PROBLEM

Pilot reports of inadequate cabin heating temperature regulation.
Recent increase of "Bleed Off" pilot reports.

B. REASON

GAS system heat protections may cause a "Bleed Off" situation when maximum temperature demand is selected.

C. SOLUTION

Upgrade the GAS controller to provide adequate heating temperature regulation and to reduce possible "Bleed Off" situations.

DESCRIPTION : To change GASC heating control logics.

APPLICATION : On Service Bulletin publication.

WARRANTY : Parts and manhour will be covered under warranty, except cabin inlet overtemperature switch. This campaign will end 1 year and 1 month after the original SB issuance reference date.

PROCURABLE MATERIAL :

- Parts to be ordered from your TBM spare parts distributor.

For aircraft equipped with A300 calculator P/N 82024A030301

Topic	Part number	Description	Qty/aircraft
21-60-07	6046297293	Cabin inlet overtemperature switch P/N 92244B010002	1

CONSUMABLE MATERIAL or OTHER PRODUCTS (Local purchase) :

- None

TOOLS :

- Insertion/Extraction tool M81369/1-02 or equivalent

SERVICE BULLETIN

SB 70–226

21

ATA No.

RECOMMENDED

The technical content of this document is approved
under the authority of DOA No. EASA.21J.013

MANPOWER :

- 1 aeronautical electrician : 2 hours

TECHNICAL INCIDENCES :

- Not applicable

DESCRIPTION OF ACCOMPLISHMENT INSTRUCTIONS :

NOTE :

Operations required in this Service Bulletin must be accomplished by persons authorized by their Airworthiness Authorities and according to the procedure described hereafter.

A. PREPARATION

- 1) Make sure the "SOURCE" selector is set to "OFF".
- 2) Install the warning sign prohibiting "SOURCE" selector operation

WARNING

**DO NOT OPERATE
MAINTENANCE WORK IN PROGRESS**

- 3) Remove upholstery panels 267 and 268L – refer to Chapter 25–21–01 of the Maintenance Manual.
- 4) Open "AIR COND" circuit breaker.

B. A300 CALCULATOR WIRING MODIFICATION – see Figures 1 and 2

- 1) Disconnect A300–P1, P2, P3 and P4 connectors.

S/N 434 to S/N 684

- 2) Open A300–P4 connector.
- 3) From the wiring harness, retain the wire(s) removed from the connector, then remove heat-shrinkable sleeve used to isolate the contact.
- 4) Using insertion/extraction tool, remove and relocate as follows :
 - HPB71–22 into stud 2.
- 5) Close A300–P4 connector.

S/N 687 to S/N 1097

- 2) Open A300–P2 and P4 connectors.
- 3) In accordance with Figure 2, cut the sheath and open A300–P2 and P4 wirings.
- 4) From the wiring harness, retain the wire(s) removed from the connector, then remove heat-shrinkable sleeve used to isolate the contact.

SERVICE BULLETIN

TBM AIRCRAFT

SB 70-226

21

ATA No.

RECOMMENDED

The technical content of this document is approved
under the authority of DOA No. EASA.21J.013

5) Using insertion/extraction tool, remove and relocate as follows :

- HPB71-22 into stud 2,
- HNB88-22 into stud 8,
- HBN87-22 into stud 20.

6) Recondition the wiring harness with tie-wraps.

7) Close A300-P2 and P4 connectors.

All

8) Check wiring continuity – refer to Wiring Manual. Take following precautions :

- connect a grounding cable to the aircraft and to an approved ground rod,
- open "AIR COND" circuit breaker,
- check wiring continuity.

C. A300 SOFTWARE UPGRADING

For aircraft Pre-SB70-180-21 equipped with A300 calculator P/N 82024A030301

- 1) Remove and discard S210 switch – refer to Chapter 21-60-07 of the Maintenance Manual.
- 2) Install new S210 switch P/N 6046297293 – refer to Chapter 21-60-07 of the Maintenance Manual.

All

CAUTION

OPERATIONS REQUIRED IN LIEBHERR SERVICE BULLETINS MUST ONLY BE ACCOMPLISHED BY DAHER AUTHORIZED PERSONS

- 3) Contact DAHER to apply LIEBHERR SB No. 82024-21-01 or SB No. 82024A-21-04 at the latest revision on the calculator.

DAHER – Direction des Services
Attn. : Maud MALLET
65921 TARBES Cedex 9
FRANCE
Phone. : +33 (0)6 85 77 71 70
m.mallet@daher.com

or for Americas

DAHER
Attn. : Philippe SANTORO
601 NE 10th Street
Pompano Beach, FL 33060
USA
Phone : 1 (954) 609 3572
p.santoro@daher.com

SERVICE BULLETIN**SB 70–226****21**

ATA No.

RECOMMENDED

The technical content of this document is approved
under the authority of DOA No. EASA.21J.013

- 4) The Post–MOD P/N of the calculator is defined according to the table hereunder

LIEBHERR P/N Pre–MOD70–0454–21	LIEBHERR P/N Post–MOD70–0454–21	DAHER P/N Post–MOD70–0454–21
82024 A 030301 82024 A 030401 82024 A 030501	82024 A 030601	6046307230
82024 A 040601	82024 A 040701	6046307229

D. RECONDITIONING

- 1) Close “AIR COND” circuit breaker.
- 2) Install upholstery panels 267 and 268L – refer to Chapter 25–21–01 of the Maintenance Manual.
- 3) Make sure all the tools and materials are removed and the work area is clean and free from debris.
- 4) Remove the warning sign prohibiting “SOURCE” selector operation.

UPDATING OF THE AIRCRAFT DOCUMENTATION :

Upon completion of Service Bulletin No. SB 70–226–21 (Reference MOD70–0454–21 “GAS CONTROLLER UPGRADE”), make an appropriate maintenance record entry.

WARNING : SOCATA considers that it is VERY IMPORTANT for operators to comply with the instructions of this SB.

Operators who arbitrarily ignore the compliance statement indicated in this SB do so at their own risk.

SERVICE BULLETIN

TBM AIRCRAFT

SB 70-226	21
	ATA No.

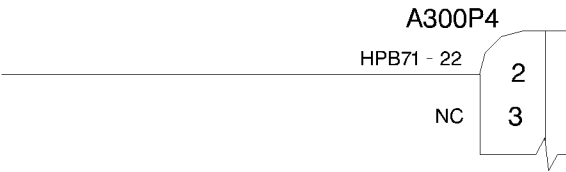
RECOMMENDED

The technical content of this document is approved
under the authority of DOA No. EASA.21J.013

AVANT MODIFICATION
BEFORE MODIFICATION



APRES MODIFICATION
AFTER MODIFICATION



14210002AAAJMA14600

Figure 1 – S/N 434 to 684 – A300 Calculator wiring modification

SERVICE BULLETIN

SB 70-226

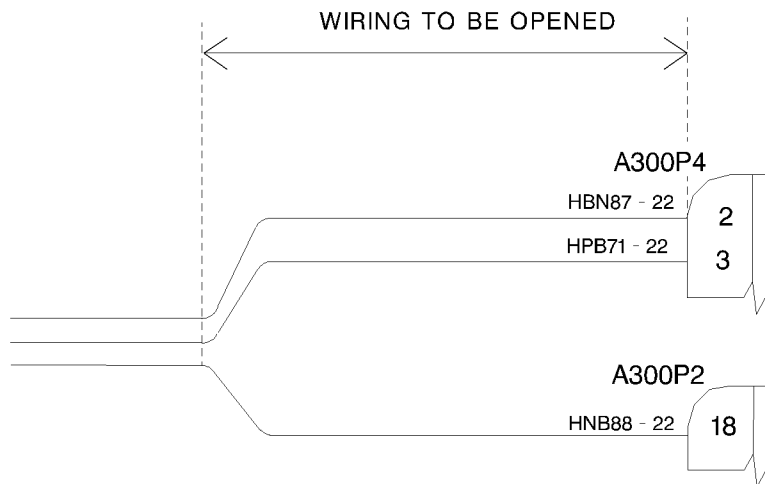
21

ATA No.

RECOMMENDED

The technical content of this document is approved
under the authority of DOA No. EASA.21J.013

AVANT MODIFICATION
BEFORE MODIFICATION



APRES MODIFICATION
AFTER MODIFICATION

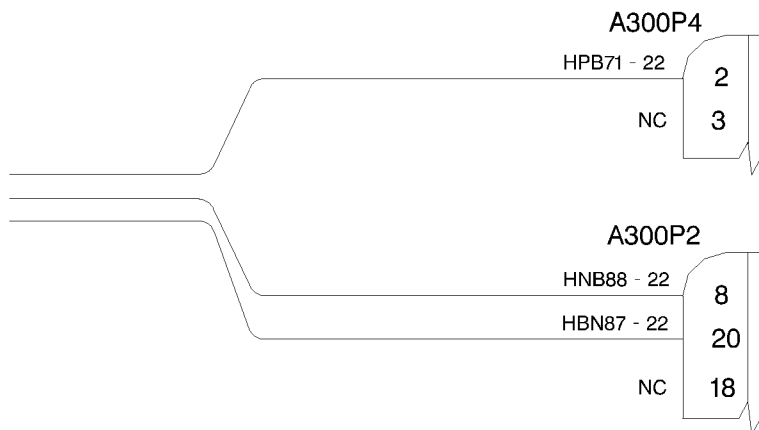


Figure 2 – S/N 687 to 1097 – A300 Calculator wiring modification

ATTACHMENT E

Pilot's Operating Handbook change of October 2015



PILOT'S OPERATING HANDBOOK

TBM 900

(TBM 700 N VERSION)

Edition 1 - December 5, 2014

Temporary Revision 18 - October 2015

Z00.DMHFM00EE1T18EN

CAUTION : KEEP THIS PAGE AND POSITION IT BEFORE THE LIST OF EFFECTIVE PAGES.

FILING INSTRUCTIONS :

Insert this Temporary Revision No. 18 dated October 2015.

Retain this TR until it is CANCELLED by a normal revision or until replaced by a new TR.

SUBJECT : Inadequate cabin heating temperature regulation and increase of BLEED OFF pilot reports

REASON : To upgrade the GAS controller to provide adequate heating temperature regulation and to reduce possible "Bleed Off" situations.

CONCERNED PAGE(S) :

PAGE No.	PAGE STATUS	TR No. - DATE	NOTE
TR 18-1		TR18 - October 2015	New page
3.2.21	Edition 1 - Rev. 0	TR18 - October 2015	Modified page
3.3.5	Edition 1 - Rev. 0	TR18 - October 2015	Modified page
3.7.3	Edition 1 - Rev. 0	TR18 - October 2015	Modified page
7.9.3	Edition 1 - Rev. 0	TR18 - October 2015	Modified page

WAITING FOR APPROVAL

"BLEED TEMP"

Indicates overheat of bleed air system. Normally this leads to BLEED cut off and to **"BLEED OFF"** amber warning CAS message appearance.

FLY THE AIRPLANE

Should automatic cut off occur or not :

- 1 - If possible **REDUCE POWER**
- 2 - **"HOT AIR FLOW"** distributor **turn to the right**
- 3 - **"CONTROL"** selector **COCKPIT**
- 4 - **"TEMP/°C"** selector **MINI**
- 5 - **"BLEED"** switch **OFF/RST**
- 6 - **"BLEED"** switch **AUTO**

If "BLEED TEMP" and "BLEED OFF" warnings still ON :

- 7 - If necessary **EMERGENCY DESCENT**
- 8 - Continue **FLY THE AIRPLANE** ... at an **ALTITUDE < 10000 ft**

If "BLEED TEMP" ON (No "BLEED OFF") :

- 9 - Shorten the flight
- 10 - Inform maintenance department

"BLEED OFF"

Possibly due to :

- system malfunction
- "BLEED" switch on "OFF/RST" position

1 - CHECK "BLEED" switch position and CORRECT

2 - If possible, reduce power

FLY THE AIRPLANE

3 - "BLEED" switch OFF/RST

4 - "BLEED" switch AUTO

If in flight

5 - If warning "BLEED OFF" still displayed :

6 - Limit flight altitude to maintain cabin altitude < 10000 ft

7 - If necessary, EMERGENCY DESCENT

8 - Continue flight

If on the ground

5 - "BLEED" switch OFF/RST

6 - Taxi back to the apron

AUCUN LIEN

Normal engine shut-down

8 - Inform maintenance department

WINDSHIELD MISTING OR INTERNAL ICING

Symptoms : - Mist or ice on windshield internal face

- 1 - "TEMP/°C" selector **Set to 12 o'clock position**
- 2 - "HOT AIR FLOW" distributor **turn to the left**
- 3 - "WINDSHIELD" switch **ON**

If not successful, to gain sufficient visibility :

- 4 - "HOT AIR FLOW" distributor **fully turn to the left**
- 5 - Manually clean a sufficient visibility area.
- 6 - If necessary, clean L.H. side window and conduct a sideslip approach (rudder pedals to the right) in order to get sufficient landing visual references.
- 7 - For landing with flaps LDG, maintain :

IAS ≥ 95 KIAS

CAUTION

IN CASE OF SIDESLIP APPROACH WITH PEDAL ON THE RIGHT DURING A LONG PERIOD, SELECT R.H. FUEL TANK

Heating circuit

Hot air coming from the bleed air system is mixed with the cabin recirculating air in the Mixing Ejector (MIXEJ) in order to lower the blown air temperature. The resultant air flow enters the Hot Air Distributor (HAD) and is distributed in the cockpit / cabin zones regarding the demand.

It is dispatched :

- in the cockpit through ports located on pedestal sides, under each seat or through the demisting outlets.
- in the cabin through ports located on the lower section of the L.H. and R.H. side cabin upholstery.

The "HOT AIR FLOW" distributor allows to select the windshield defog / cabin heating functions.

When the "A/C" switch is set to OFF position, the temperature is set by default by the GASC to 23°C.

Cooling circuit

There are two separate circuits : one for the cockpit and the other for the cabin.

In each circuit, air is sucked by means of a variable speed electrical fan, then it is blown through an evaporator and ducted to the different zones :

- cockpit circuit : by passing into the upper panel equipped with 2 swivelling and adjustable air outlets, through air outlets located on arm rests of pilot and R.H. front passenger stations and through ports located under instrument panel,
- cabin circuit : by passing into the overhead duct equipped with 4 swivelling and adjustable air outlets and through ports located on the floor between the cabinets and the intermediate passenger's seats.

The VCS can be switched on, only if the fans are set at least to minimum speed. The compressor clutch and the condenser fan are controlled by the GASC.

In automatic mode, the temperature of each zone is controlled independently by the system according to the settings of the "TEMP/°C" and "CABIN TEMP/°C" selectors, which can vary from 17°C to 32°C. In this mode, the speed of each fan is automatically controlled.

In manual mode, the blown air temperature is controlled by the system according to the settings of each temperature selector. In this mode, the speed of each fan is set manually from Off to maximum speed position.

The "A/C" switch allows to switch on or off the Vapor Cycle System.

- If set to AUTO position :
 - . on "ECS" panel, the "TEMP/°C" selector enables to select requested temperature of the cockpit zone,
 - . above arm rest of L.H. passenger's seat, the "CABIN TEMP/°C" selector enables to select requested temperature of the cabin zone.
- If set to MANUAL position :
 - . on "ECS" panel, the "TEMP/°C" selector enables to select requested temperature and the "FAN SPEED" selector enables to choose blown air speed in the cockpit zone,
 - . above arm rest of L.H. passenger's seat, the "CABIN TEMP/°C" selector enables to select requested temperature and the "FAN SPEED" selector enables to choose blown air speed in the cabin zone.

The "CONTROL" selector set to COCKPIT position inhibits the operation of the controls located in the cabin zone ; only the cockpit controls settings are taken into account. If set to CABIN position, each zone controls its proper values.

Emergency air control ("EMERGENCY RAM AIR" control knob), located under R.H. area instrument panel facing control wheel, enables outside air to enter the cabin through a valve. In NORMAL position, the valve is closed and the control is locked. To open emergency ventilation valve, press on locking knob and move control rearwards.