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Transport*



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Demonstration of ATSB's New Technical Capabilities Through a Case Study

Alex Talberg

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Technical Analysis



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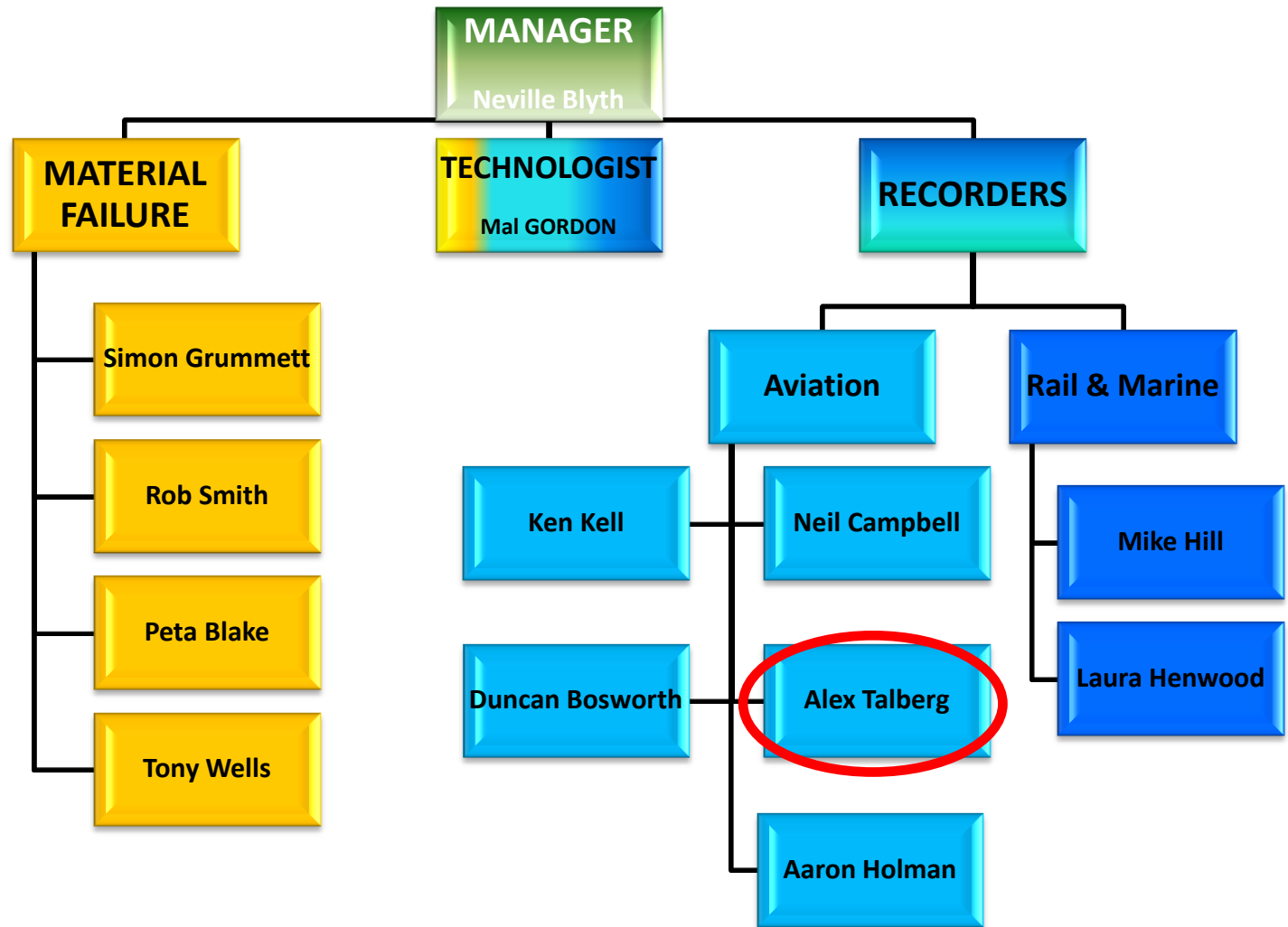
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Vision and Mission

The aim of the Australian Transport Safety Bureau is to maintain and improve transport safety and public confidence through excellence in

- *independent investigation of transport accidents and other safety occurrences;*
- *safety data research and analysis; and*
- *safety communication and education.*

Technical Analysis



Recorders Team

- Generally conventional flight recorders
- FDR, CVR, QAR, Radar data
- Developing knowledge of other recorders
- Last 2 years developing 'chip recovery' system
- Best demonstrated through a case study.



Case study – Assistance to the RNZAF

- 14 January 2010 a Red Checkers CT/4E Airtrainer crashed while performing aerobatics.
- Occurred during a solo manoeuvre
- Pilot fatally injured
- Post impact fire



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Case study – Assistance to the RNZAF

- A month earlier, fleet was fitted with GAU1000 Appareo Systems fatigue recorders as part of a fatigue monitoring programme.
- From the Appareo Systems website:

“The GAU 1000 improved upon standard GPS technology by adding gyroscopes, accelerometers, barometric pressure sensors and a solid state compass,...”



Case study – Assistance to the RNZAF

- Appareo Systems GAU1000:
 - Records onto SD/MMC card
 - Internal battery
 - Mounted in the rear of the cabin using hook and loop fasteners (Velcro)
 - No crash or fire protection



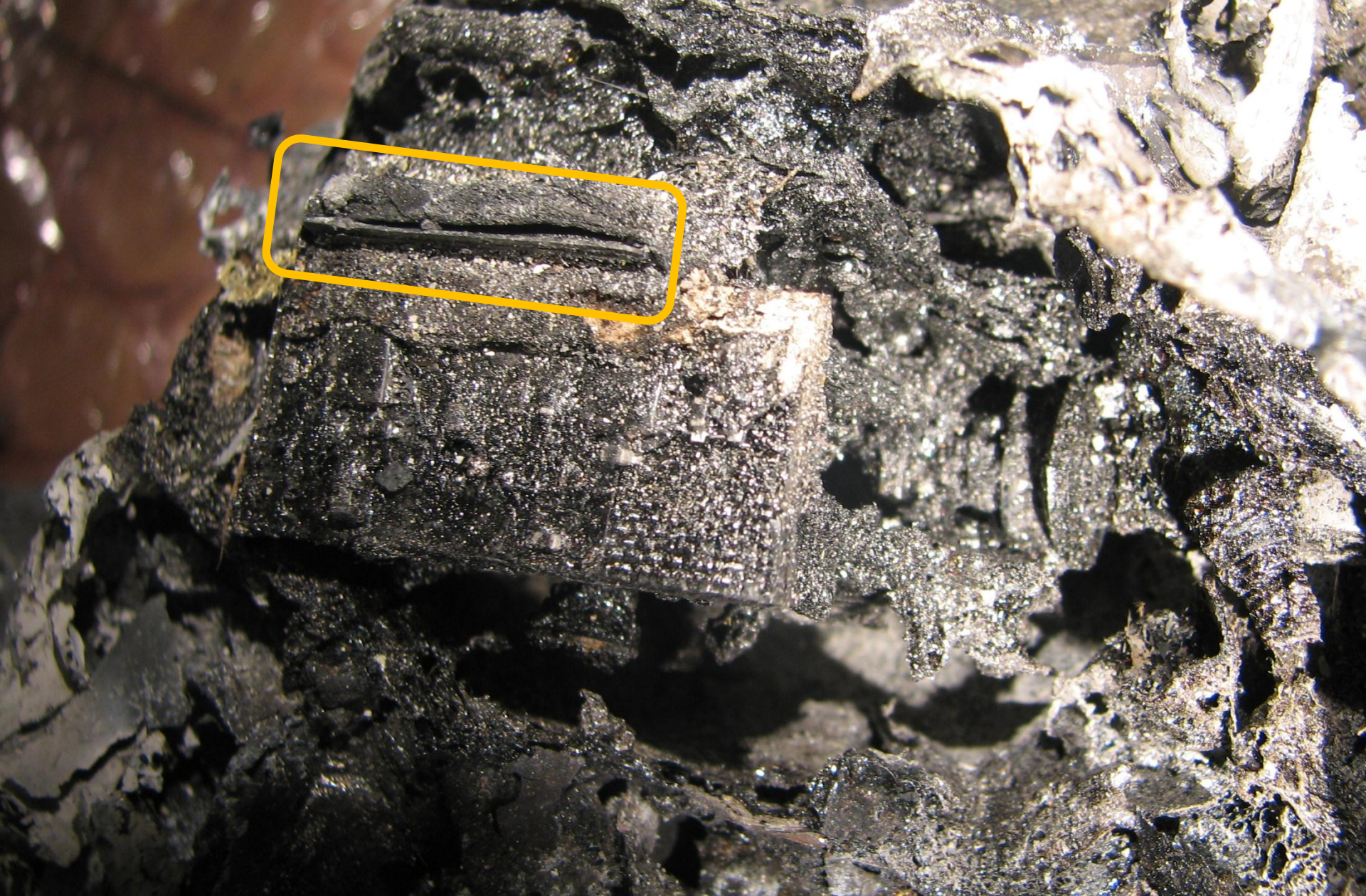




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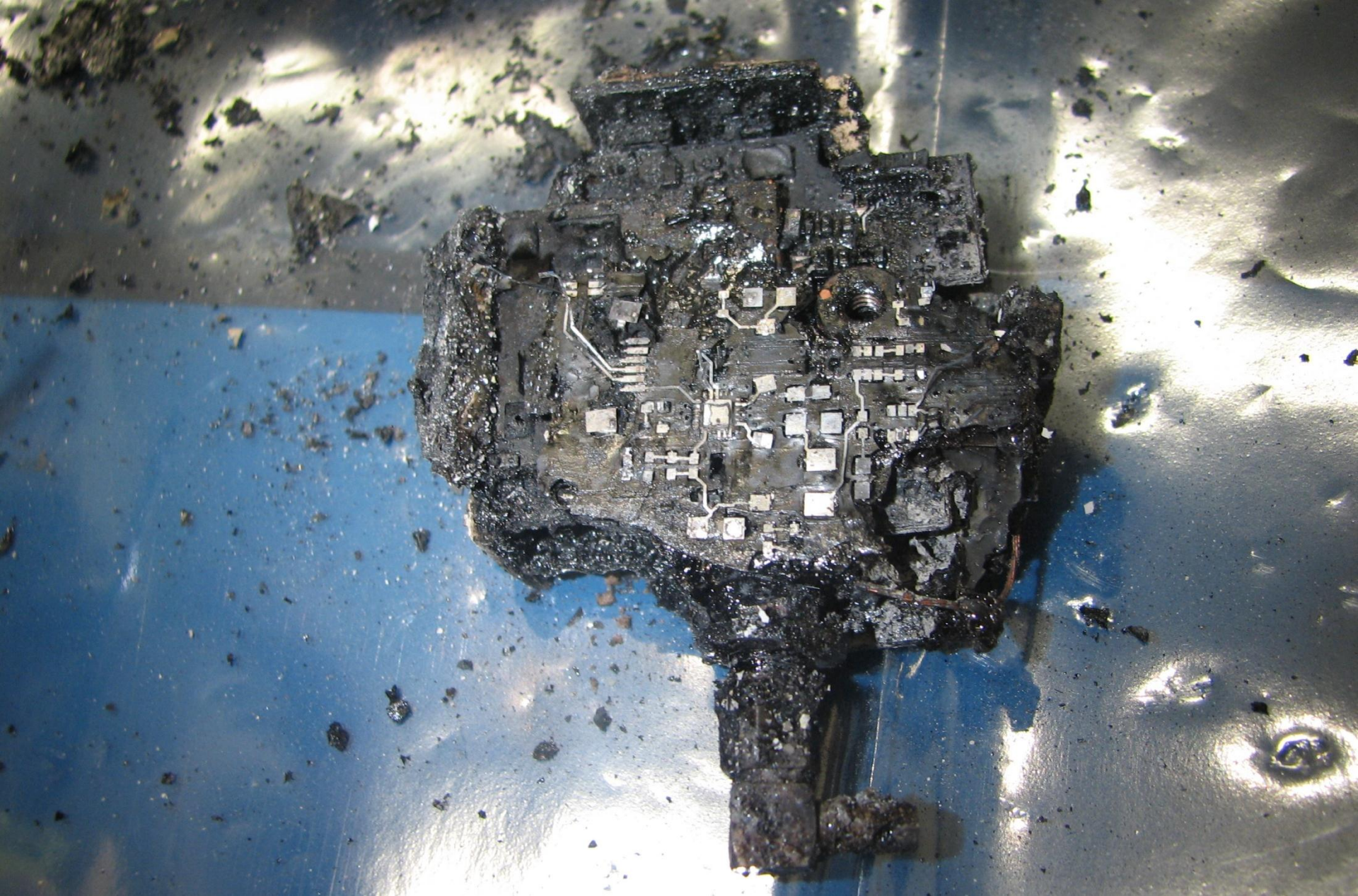




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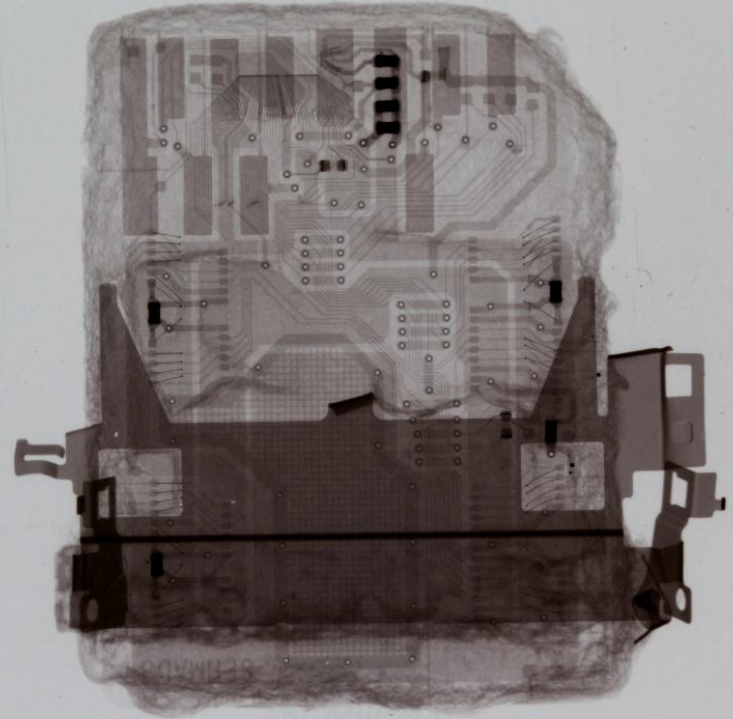
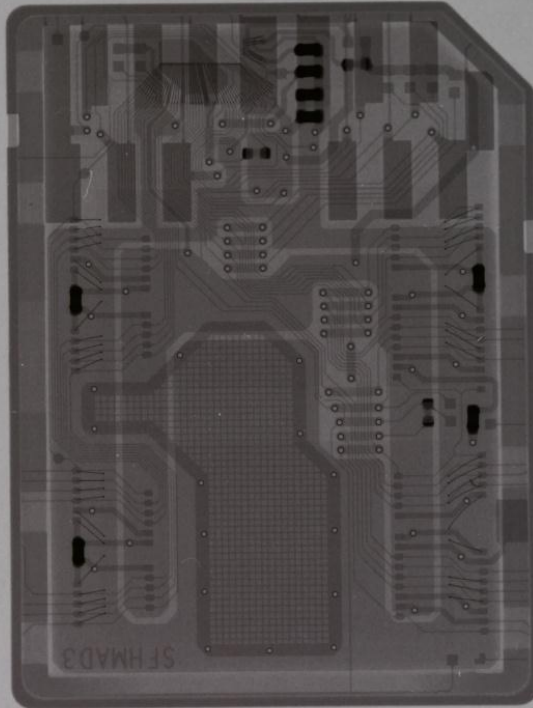


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SD/MMC Card X-Ray comparison



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SD/MMC Card

Attempted recovery using the native interface of the card

Practice on undamaged card worked fine

No luck with accident card

After many attempts, work was put on hold



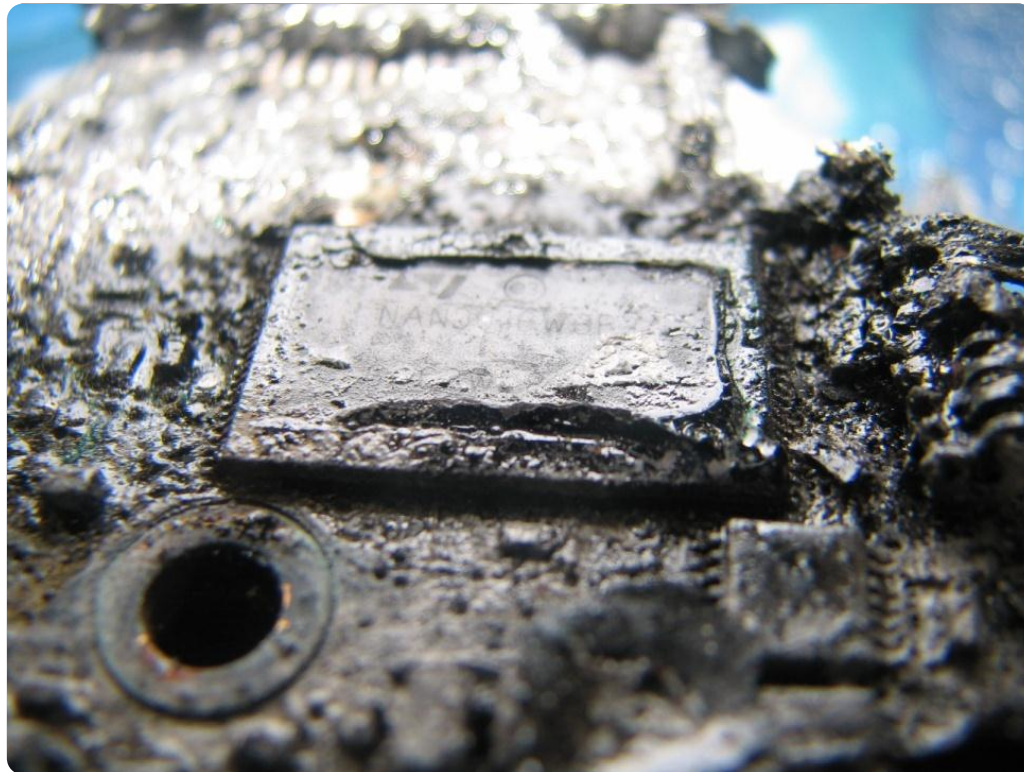
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Remaining electronics

- Manufacturer advised that unit writes simultaneously to Flash and to SD/MMC card.



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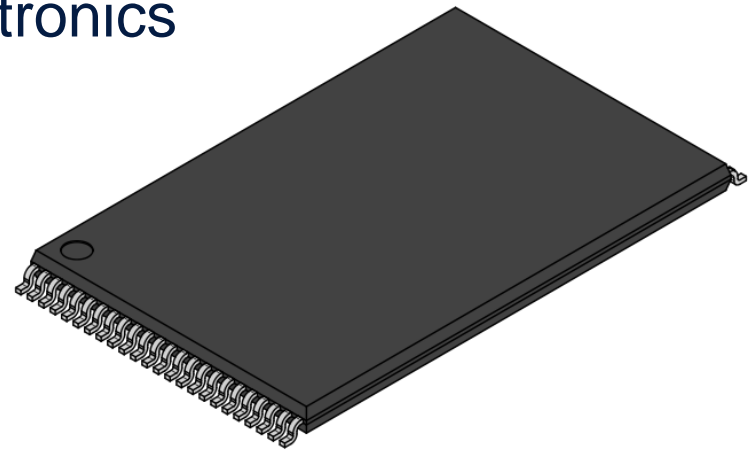


Flash Memory

- Solid-state data storage (non-volatile)
- 2 flavours, NOR and NAND
- 2 main package types
- Used in most modern electronics



BGA
Ball grid array

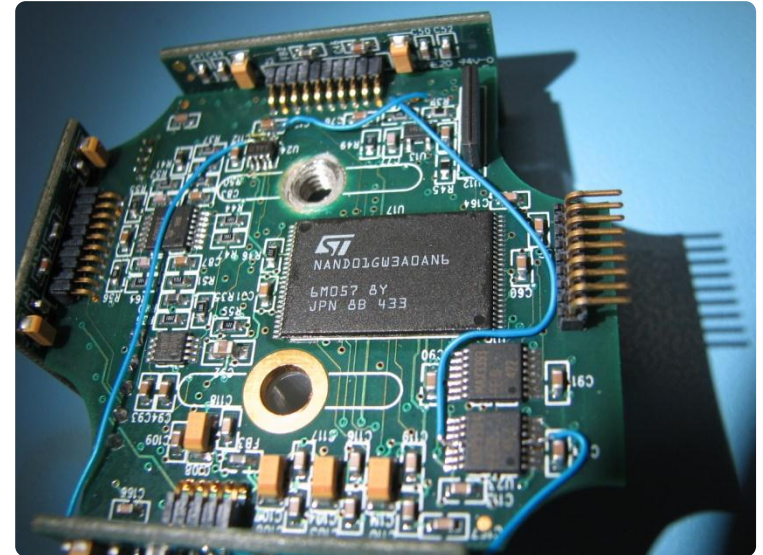


TSOP
Thin small outline package



NAND Flash Memory

- Manufacturer sent prototype boards for procedure verification
- Provided reflow profile (not needed as device simply fell off the board when charred plastic was removed!)



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NAND Flash Memory

- Device was carefully cleaned under the microscope using mechanical means and small amount of contact cleaner
- Pins were re-tinned
- Before
- After



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NAND Flash Memory Reader

- Read performed using the Xeltek Superpro 5000
- No problems encountered
- 134 MB file recovered



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RAW BINARY DATA

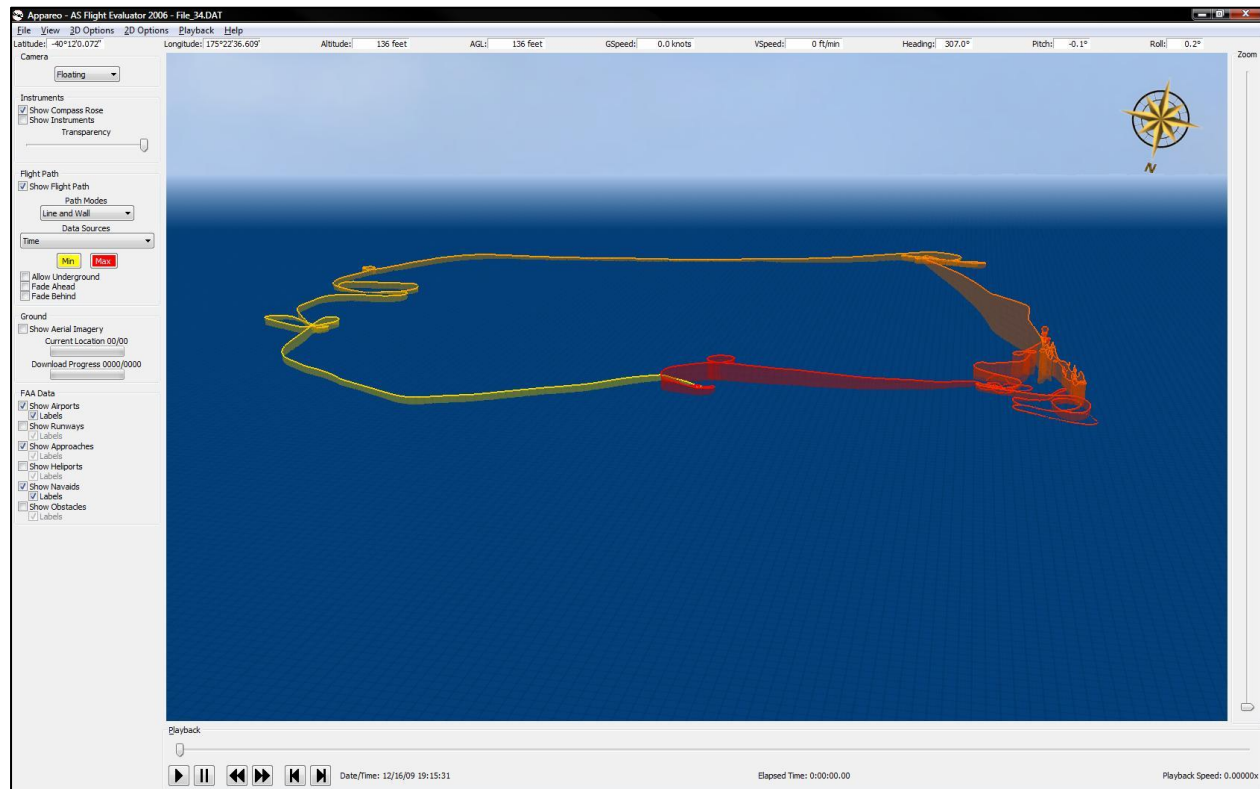
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00000010h: 32 2E 34 68 6E 45 53 09 52 57 32 2E 30 2E 30 20 ; 2.4hnES.RW2.0.0
00000020h: 0E 45 53 09 52 45 52 20 31 2E 38 20 29 45 53 74 ; .ES.RER 1.8 )Est
00000030h: 52 54 01 76 4F 8D AA 3E DD 88 AE 65 8B 87 32 9A ; RT.vO >Y@e<+2š
00000040h: EB 03 B4 FD BD AD B8 A5 2E FA BB 59 49 31 BE 6C ; ë."ý*-,"ú»YI1¼l
00000050h: F6 82 2C 50 4F 16 B0 BB 49 8B 2F 58 4A 61 36 2A ; ö,,PO."»I</XJa6*
00000060h: D9 B3 B8 3C 2F 9B BB B4 AD 8F 3F 22 F9 47 A9 4A ; Û:./>»'- ?"ùGEJ
00000070h: 26 86 2D A9 2A 80 B0 7A 5D 45 B3 3D 18 53 36 CD ; &t-0s<»z]E'=5.6f
00000080h: A8 EA 37 0C D3 73 3C 9C A0 A6 AA EB 79 36 2E B2 ; "ë7.0s<»!>ëy6."
00000090h: 47 7C B0 90 14 B4 B3 F9 94 3B 36 58 E8 03 39 AF ; G|'.">ù";6Xë.9
000000a0h: B9 C9 39 9F 45 53 74 52 54 02 4D F5 16 2B AB BF ; >ë9YESTRT.Mö.+<ë
000000b0h: 4D AF DB 35 67 32 AA 93 4F 35 6D 45 85 B8 7E D7 ; M"Üsg2"»05me...~*
000000c0h: BA BB 6A 00 C7 BE C0 9A 11 AA 8C DB B5 2D 92 C9 ; >»j.CjÅš."@Üu-'É
000000d0h: 04 B0 EF 51 93 B3 74 A4 00 36 9C 70 28 39 DE 33 ; ."Q"»t..6exp(9B3
000000e0h: 9A 3C 79 26 3E AA 40 E6 0E 2E 73 75 CA B0 C3 2B ; š<y>»<@..suë"Å+
000000f0h: 3F B3 5F 5C 7E 36 51 79 16 36 74 D0 C6 3B D2 FB ; ?>\"~6Qy.6tDE;öü
00000100h: 51 2C 99 2A E9 AF 0D 40 80 B1 B9 73 4E 36 81 D0 ; Q,"»é".@ë±"sN6 ð
00000110h: 97 B8 B4 01 96 BB A0 6E 8A 3F D7 45 53 74 52 54 ; -,".-» nš?>ESTRT
00000120h: 03 17 27 9A AA DF A8 C1 AE 13 C7 80 32 15 15 E1 ; .."š»B"Åö.çE2..ä
00000130h: 34 0B DD AA B8 35 71 06 BC 31 D7 A8 BE E5 77 5B ; 4.Y".5q.4i"»Xåw[
00000140h: 2C 1D E0 E3 AF 5A 8A 12 B2 08 DD 5B 36 8F C4 71 ; ..ää"zš."Y[6 Åq
00000150h: B8 74 9A AC BB D5 02 8B 3F C0 48 91 A9 D8 F1 86 ; ,tš->ö<.>?ÅH"öñ+
00000160h: 2D DF 93 5E B0 E5 8B EF B2 13 B3 1D 36 E3 BF C3 ; -Bš"»öÅk"i".6äzÅ
00000170h: B7 A8 B1 0B 3C 5F 62 84 AA 81 C3 E2 2D 32 DD 4D ; -"±.< b," Åä-2YM
00000180h: B0 4B 81 2E B1 C4 30 01 36 34 A4 78 38 83 15 76 ; *K.±Åö.64»xšf.v
00000190h: BC 22 45 53 74 52 54 04 09 85 54 2B 23 9C 80 AF ; 4"ESTRT...T+»öE
000001a0h: BE FC 5D 32 C5 66 A4 35 F6 05 86 B8 A5 98 E1 BB ; Xü]2Åf»5ö.t,"Y"ä»
000001b0h: D8 EF 11 BF 04 A8 EB 28 5B F8 3D AD 33 2F F9 2F ; öi.ç."ë([ø=-3/ù/
000001c0h: 9B E3 E4 32 22 47 60 B5 79 14 D3 37 F0 5A 72 3C ; >äš2"G"uy.ö7öZr<
000001d0h: F9 21 5F 2C FA EF E4 AF BF 26 0F B2 E9 B6 59 36 ; ù!,"öä"ëç..ëY6
000001e0h: 78 D5 7A B8 F6 3C A5 BB 19 A2 87 3F 87 ED B9 A9 ; xÖz,ö<»>.ç?+i"ö
000001f0h: 4B 6A BD 2D 1E 02 97 B0 B9 1B 83 B3 A2 AE 44 36 ; Kj»-..-."f"»öD6
00000200h: 8E 8C 08 39 56 CC 10 3C 16 45 53 74 52 54 05 2D ; Zë.9vI<..ESTRT.-
00000210h: CC D8 2A 59 70 13 AF 61 0C 1C 32 7D 88 30 35 CF ; iö"Yp..Å.2">05I
00000220h: D7 50 B8 89 70 A6 BB 82 C1 AA BE 31 35 D4 2A 71 ; *P,kp]»,Å"»15ö*q
00000230h: E2 77 AE 85 F7 9D 30 D9 99 00 34 CA 06 49 B6 A3 ; äwö...öÜ"»4ë;Iqë
00000240h: C6 47 B8 E0 0F 0B 3B 66 FE 59 2C AD E6 AE 30 ; >ëš.ä..;fpY.,»=0
00000250h: 67 FD B1 7F EB 58 36 8C 52 76 B8 BB 7B B1 BB 36 ; gy± äX6ERY.»[±»6
00000260h: 6B 8B 3F 0D 41 01 29 43 F8 D4 2C CD A1 A8 B0 A7 ; k<?A.)Cöö,Í;»S
00000270h: F3 CB 31 9A 03 65 36 70 75 89 B8 B7 E3 0C BC 88 ; öëIš.e6puk..ä.4"
00000280h: 45 53 74 52 54 06 FF 56 59 2A 5C 67 00 AF BD 4A ; ESTRT.yvY\"g."»J
00000290h: 01 32 C6 16 5B 35 70 20 1A B8 D0 4A 86 BB 19 33 ; .2E.[5p ..DJt+.3
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0 1 2 3 4 5 6 7 8 9 a b c d e f
00000000h: 53 07 52 49 7D 04 00 00 7F 45 53 09 52 48 52 20 ; S.RI[...]... ES.RHR
00000010h: 32 2E 34 68 6E 45 53 09 52 57 32 2E 30 2E 30 20 ; 2.4hnES.RW2.0.0
00000020h: 0E 45 53 09 52 45 52 20 31 2E 38 20 29 45 53 74 ; .ES.RER 1.8 )Est
00000030h: 52 54 01 31 E2 FB 28 D9 C5 0A AE 61 38 E7 30 89 ; RT.1äü(ÜÄ.öašç0%
00000040h: F9 87 34 5F 6E 9C 36 1C 65 83 B8 25 13 A7 BD 59 ; ù+4_nœ6.ef,š.š»Y
00000050h: FC 69 2C E0 AC FA AF E4 98 AE B1 96 12 59 36 C2 ; üi,ä-ü"ä"»±-.Y6Å
00000060h: DC 8F B8 F0 DB 9C BB EA D1 8D 3F B1 04 5A 29 E8 ; Û,öÜ»»ëñ ?±.Z)ë
00000070h: 00 6E 2C C7 5C 8F B0 22 D6 38 32 12 08 25 36 86 ; .n,ç\"»"öë2..»6+
00000080h: FC 27 38 00 A0 39 3B 0C A3 A2 A9 69 D9 8B 2D E3 ; ü"8. 9;..ëçöiÜ<-ä
00000090h: E0 A2 B0 82 10 C7 30 4B 1F 3B 36 87 BC 60 38 23 ; äç°,ççOK.;6+4"8#
000000a0h: 0D 4D BC 99 45 53 74 52 54 02 9C 04 2A AA 9F 97 ; .M»ESTRT.ç."»Y-
000000b0h: 40 2D 3F AA 2C 31 C7 9D 7D B4 28 67 60 B6 51 CA ; @-?*,1ç )'(ç"Që
000000c0h: 51 BA B1 48 D0 3D A4 FB 98 29 11 37 9C AC 48 19 ; Q»±HD»»ü")..7»-H.
000000d0h: 06 B0 A1 48 98 31 11 B2 03 36 36 2D 5D 38 5D B9 ; .";H"1."66-]8"±
000000e0h: 64 3C D0 FC 02 AA 6A 9E A5 2D 95 32 1A B0 86 3C ; <kDü."jžY-»2."ö+<
000000f0h: D1 B2 E5 BF AD 35 BF 69 B9 B7 F5 54 1C BC 4D DC ; N"äç-5ç1"»öT.4MÜ
00000100h: 3C 2C FB 48 C5 AF EA 92 08 B2 26 3B 4D 36 DE E0 ; <,üHÄ"ë".»ç;M6Bä
00000110h: 7C B8 FA 3B 96 BB D6 D5 8C 3F DF 45 53 74 52 54 ; |,ü;»»öçö?>ESTRT
00000120h: 03 55 08 24 AB FA B7 51 2E 54 FD 6E 31 0C 60 8C ; .U.š»ü.Q.Týn1."ö
00000130h: B4 7E B1 EF B5 A5 6B 66 BA 34 76 9B 3D AB C4 63 ; '~±iµ»kfö4v)»»Äç
00000140h: 2C E5 FC F6 AF 9C C7 92 B1 11 E7 55 36 04 D3 96 ; ,äüö çç'ä.çÜ6.ö-
00000150h: B8 86 D0 97 BB E9 C7 8D 3F 01 36 10 AA E6 BF E1 ; ,tD»ëç?2.6."»çä
00000160h: 2D 62 FD 76 B0 09 5D 95 B3 14 7F 61 36 9D D9 6C ; -byv".]".»a6 ÜI
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00000180h: B0 6C B2 32 B0 32 71 BA 35 C7 85 E0 38 2F 76 28 ; "1"2"2q»çç..äö/v(
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000001a0h: E3 90 E8 31 4E 08 45 34 91 A1 C1 B7 CC 1E 26 BB ; ä è1N.E4';Ä.ä.ë»
000001b0h: 83 29 80 BD 26 4A D4 A9 8F 07 3E 2D 72 98 0C AF ; f)ë»ççöç.ö>-r"-
000001c0h: BE 48 E4 B2 A9 14 F1 35 E5 D6 B2 37 B1 73 41 3C ; %Hä"»ö.ñšÅö"7±sA<
000001d0h: 56 D9 61 2C C9 E7 F2 AF 12 E8 A3 B1 4F 69 54 36 ; VÜa,ëçö",ëz±öiT6
000001e0h: 7C B5 91 B8 9C 04 99 BB C1 C2 8A 3F 58 E6 8E AA ; |µ'.»»»Äšš?X»ž"
000001f0h: A4 1D 3C 2E DB 76 B5 B0 51 04 C8 B3 FF B0 38 36 ; ».<.Üvu"Q.ë"Y"86
00000200h: E4 88 1E 39 0F 56 2C BA B8 45 53 74 52 54 05 A2 ; ä".9.v."»ESTRT.ç
00000210h: 55 94 2A B5 7A 70 AE DB F8 B1 30 3F 25 A6 34 5D ; U"»uzpöÜö±ö?»;4|
00000220h: C6 A8 35 81 05 FA B9 0C 78 B3 BD 88 E1 BA 29 08 ; E"5.ü".x"»ç.ä°).
00000230h: CF 7A AD E8 20 D3 2F E9 2F C2 32 49 76 C3 B3 45 ; İz-ë ö/ë/Ä2IvÄ"E
00000240h: BB 24 38 B8 45 C9 3A 6D 46 66 2C 6D 87 FA AF 3E ; »š8,Eë:mff..äz±öiT>
00000250h: 8B B4 B1 52 B3 59 36 70 02 85 B8 EC 4D 9F BB 65 ; <"±R"Y6p...iMÝ»e
00000260h: 4B 8A 3F 80 5C 06 2A 7C 2B E9 AC B8 F2 6B B0 F9 ; Kš?ë\."*|»-ëçök"ü
00000270h: 48 01 33 CC 35 B3 35 03 5B 85 38 7E 50 06 BC 5F ; H.šİš5".[...8-P.4"
00000280h: 45 53 74 52 54 06 84 19 A7 A9 1C 67 FE AD D7 F9 ; ESTRT...šöçp-»ü
00000290h: 99 31 1F 43 ED 33 23 87 38 B7 15 98 16 BB 0E 2D ; "1.Ciš#»8".»..»-
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NAND Flash Memory

- Flights recovered from the initial product testing at the factory, to the accident flight (47 in total).



Finally

- Highlights the benefit to investigations of good manufacturer cooperation
- Validates the ATSB's investments in advanced data recovery techniques
- The safety message...



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Questions ?



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