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PAN AM 103
OVERSEAS HOMICIDE/ATTEMPTED HOMICIDE
INTERNATIONAL TERRORISM

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An Improvised Explosive Device (IED) exploded onboard Pan Am Flight 103, on December 21, 1988, killing 259 passengers and crew members. The debris from the aircraft fell on Lockerbie, Scotland, killing 11 residents. Forensic Scientist at the Forensic Laboratory, Royal Armament Research and Development Establishment (RARDE), Fort Halstead, Seven Oaks, Kent, England, have determined that the IED was contained in a black Toshiba radio, model SF 16.

Recovered from the wreckage of Pan Am Flight 103, was a gray Slalom Shirt, which exhibited signs of blast damage. The Scottish Police have identified this shirt as production number PI 995. An examination of this garment, production number PI 995, by Forensic Scientist at RARDE, determined that this shirt appears to have been contained in the suitcase which contained the IED. Investigation to date has determined that this shirt, along with approximately twelve additional items of clothing and apparel, were purchased by an unidentified individual, on or about December 7, 1988, at Mary's House, Sliema, Malta. Mary's House in Sliema, Malta is a retail clothing outlet.

On January 22, 1990, Forensic Scientist at RARDE advised that they had discovered, trapped in the Slalom shirt, production number PI 995, several fragments of black plastics, consistent with the case of the Toshiba radio, a fragment of

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green circuit board, minute fragments of metal and wire, and several multilayered fragments of white paper bearing black printing. The white multilayered paper fragments have been identified as originating from the instruction manual for the Toshiba SF 16 radio. RARDE separated the black plastic fragments, green circuit board fragment and metal and wire from the Slalom Shirt (PI 995), and have identified these items as production number PT 35.

The Scottish Police have determined, after extensive investigation, that the green circuit board (PT 35) is single sided and composed of nine (9) layers of glass cloth, type 7628. It (the green circuit board) is described as a one ounce, copper clad, FR4 epoxy glass laminate circuit board, 1.6 millimeters (mm) thick. This glass cloth laminate is manufactured using a Bisphenol A epoxy resin cured with Dicyandiamide. A solder mask has been applied to both sides of the board. The solder mask appears to be a wet epoxy base type that was either screen printed or brushed on to the board. The small tracks on the board are nominally one ten thousandth of an inch, 250 microns, with 450 microns spacing between the tracks. The tracks are coated with pure tin, probably from an electrolysis tin solution, presumably to aid in solderability. Normal electronic grade solder, 60 to 65 per cent tin (with the remainder lead), has been used to make a solder connection to the pad.

Personnel from the Federal Bureau of Investigation (FBI), Explosives Unit discovered a similarity between the circuit board fragment (PT 35) and a printed circuit board, which is a component part of an electronic timer recovered in Africa in September, 1986 (now referred as specimen K-1). On June 22, 1990, a side by side comparison of specimen K-1 and PT 35, resulted in a positive identification of PT 35, as being similar to specimen K-1. In essence, it has been determined that the PT 35 circuit board fragment originated from a circuit board that was like or identical to specimen K-1 circuit board. Specimen K-1 is described as part of a digital, battery operated, long delay timer detonator, capable of providing electrical power to fire an electrical detonator, which would initiate the high explosive main charge.

The electronic timer (specimen K-1) is crystal controlled, and can generate delays over a range of 1 to 99 minutes, in one minute increments, or 1 to 99 hours, in one hour increments. The design and assembly are described as generally professional, suggesting that a well-equipped facility and trained personnel were utilized during the manufacturing process of this device. Two errors were made in the printed circuit board routing, however, only one of these errors was repaired. The repair work is also described as well-done. The second error, which was not repaired, would only cause, at most, a 6 second error in the delay. It is noted that there is physical space and circuit trace provisions, in existence on the circuit board, to expand the range of the time delay from two decades (1 to 99 minutes or hours) to four decades (1 to 9999 minutes or hours), however, the required components were not installed. It is unknown whether this is a modified commercial or a custom manufactured device.

Control switches and labels are on the front panel, with each label etched in copper, identical to the circuit trace, except there are no components connected to the label etching. A solder mask covers the entire panel. The controls on the front panel are as follows:

two (2) thumbwheel switches labeled TENS
one (1) slide switch labeled **ON/OFF**
one (1) slide switch labeled **HRS/MIN**
one (1) push button momentary contact switch labeled **TEST**
one (1) red light emitting diode (LED).

Also etched on the front panel, in the upper right quadrant, is the inscription **MST-13**. The actual significance of this "model number" is not known.

The inside surface of the front panel has circuit traces and surface mount components installed. A solder mask also covers this surface. Traces of conductor along the edges indicate shear lines were made when the conductor pattern was etched. These shear lines indicate where the board is to be cut.

A smaller printed circuit board is mounted directly to the thumbwheel switches. This circuit board is a different color, lighter, and has no solder mask. Again surface mount components are installed on this board. Circuit traces and unpopulated component locations exist, on this board, to support two additional thumbwheel switches, however, no evidence exists that the additional components were ever installed on specimen K-1.

A length of 16 gauge zip cord connects the timer to the load, which is assumed to be an electrical detonator. A small screw terminal block is used to connect the detonator to the zip cord. The block's mounting hole has a LED and resistor mounted inside.

A single "J" battery is soldered directly to wires and is held in place with double sided foam tape. The battery mounting is strictly an afterthought, inasmuch as no space is dedicated to a battery holder. The battery is literally "stuffed in among the components".

All screw holes are countersunk, and the shear lines are square.

A "cut and jumper" repair was made to an incorrectly routed trace. The cut is made by drilling through the offending trace, and a jumper is then added. The repair job is described as "a very nicely done repair".

Two chip resistors were added "tombstone" fashion, by bending the integrated circuit leads up. This installation is not easy to do and is very labor intensive.

The crystal oscillator generates a 1 Hz clock which feeds a series of "divided by 60" counters. The output of the first "divided by 60" counter is one pulse per minute, where as the output of the second "divided by 60" counter is one pulse per hour. One of these "divided by 60" counters is selected with a slide switch, which is located on the front panel (as described above). The pulses from the "divided by 60" counters, signal clocks a series of decade counters. After the first decade counter increments ten (10) times (receives 10 pulses from the

"divided by 60"counters), a ripple carry scheme increments (signals) the next decade counter with one pulse.

The binary coded decimal (BCD) output from each decade counter feeds a BCD thumbwheel switch. When the correct count is reached, a flip flop is set, which turns on a relay to provide power to the load (an electrical detonator).

When power is provided to the load (an electrical detonator) the red LED in the terminal block (of the zip cord) will illuminate. Turning the device on with all switches set to zero (0), will actuate the relay, after the power on reset (POR) signal times out, which takes approximately 1.5 seconds. The POR circuit is a standard design used to ensure the counters are all reset to zero (0) when the power is first applied. An error in the routing of the reset line does not allow the POR to reset one of the counters. This error in the routing was not corrected, resulting in less than a six (6) second error in the timer delay.

Because the battery is stuffed in haphazardly, with no insulation or protection, the bare wire battery joints might contact a circuit element. This could cause the timer to fire early, late, immediately, or perhaps not at all.

The device examined (specimen K-1) had no safe arm delay, no energy storage circuit, no low voltage detector, and no booby traps.

Special photography techniques were utilized on specimen K-1 to identify the number/letter "21B" which is contained within the figure of an oval. The number/letter appears in the upper left quadrant of the circuit board, within the lamination and not on the surface of the board. This identification was added during the manufacturing process, and may offer a code to identify the source of this board. It should be noted, however, that the company which applied the actual printed circuit, may not be the company which manufactured the green circuit board.

Additional special photography techniques were also utilized to recover a set of partially eradicated letter/numbers combination, "M580", which appeared on the second, and smaller,

circuit board. Another set of numbers, on this second smaller circuit board was observed under the microscope, however, the eradication was more complete, with only the second number, the number 2, of three raised.

Investigation at Underwriters Laboratories (UL) has determined that the letter number combination "M580", on the second smaller circuit board, could possibly be associated with the following Japanese Company, in as much as they identify their products with a three digit number, preceded with the letter M:

Meiko Industries, LTD.
9-29 4-Chome Nishi Hashimoto Sagamihara
Kanagaw-Ken

The following is a partial listing of the various component parts of specimen K-1, with a cross reference to what is believed to be the manufacturer of that component:

Component	Markings	Manufacturer
Quartz Crystal	NYMPH 4.194304 NYPO 49-12	Saronix 151 Laura Lane Palo Alto, California
Integrated Circuit Chips	HEF 4521 BT HEF 4518 BT HEF 4001 BT HEF 4093 BT	North American Phillips Signetics Company 811 East Arques Avenue Sunnyvale, California
Relay	F HZ3 211A D006-M	Fujitsu United States address not yet identified

Investigation at Saronix, Palo Alto, California has determined that the NYMPH (trademark) NYPO 49-12 Quartz Crystal has been manufactured since mid-1983, by Kony Precision Company, Limited, Inchon, South Korea. Officials at Saronix, after reviewing photographs of the quartz crystal utilized in specimen K-1, advised that the crystal was not manufactured until mid-1986, because the crystal had a gray vinyl wrapping. The equipment for this vinyl wrapping process was not installed at the manufacturing facility until some time in mid-1986.

A review of the sales records from Saronix, for the period from June, 1986 (mid-1986) until September, 1986 (the month when the electronic timer was recovered in Africa), has determined that 5,960 crystals were shipped to twelve customers. The following is a summary of sales of the crystal, by company, for this time period:

Company	Quantity
Analog, Inc 1709 NorthWest 79th Avenue Miami, Florida 33126	2,600
Anthem Electronics 1615 2200 South Suite A Salt Lake Cith, Utah 84119 (801) 973-8555 Bob Brown 1727 East Weber Drive Tempe, Arizona 85281 (602) 966-6600 1 Old Field Drive East Irvine, California 92680 (714) 768-4444 21730 Nordhoff Street Chatsworth, California 91311 (213) 700-1000 Roger Walls 373 Inverness Englewood, Colorado 80112 (303) 790-4500 5020 - 148th Avenue NorthEast Redmond, Washington 98052 (206) 881-0850	350

1040 East Brokaw Road
San Jose, California 95131
(408) 295-4200
Doris Barringer

15812 SouthWest Upper Boones Ferry Road
Lake Oswego, Oregon 97034
(503) 684-2661
Craig (Last Name Unknown) (LNU)

9369 Carroll Park Drive
Suite B
San Diego, California 92121
(619) 453-9005

A T & T Consumer Products Laboratory 350

A T & T Information Systems
Room 18635
Crawford Corner
Holmdel, New Jersey 07733
Joe Mazzeo

Compona AG 600

Hochbordst 9
CH-8600 Dubendorf
Suisse,

Ferguson Manufacturing 575

152 Kapp Street
Post Office Box 16044
Winston-Salem, North Carolina 27105
(919) 761-0924
Randy McMullan

Indelco 100

Industrial Defense Systems, Incorporated
8755 East Orchard Drive
Suite 605
Inglewood, Colorado 80111

Lynch Communications 200

204 Edison Way
Reno, Nevada 89502
(702) 786-4020
Dave Hassell

3128 Smoketree Court
Ralley, North Carolina 27611

PMMI, Inc 100

County Road #375
Old Ocean, Texas 77463

Radionix 100

Post Office Box 80012
Salinas, California 93912
(408) 757-8877
Kathy Kessler

Ten - Tech, Incorporated 250

Highway 411 East
Sevierville, Tennessee 37862
(919) 876-2224
Tom Mitchell

Wheatstone Systems, Inc 235

529 Foreman Avenue
Campbell, California 95008
(408) 559-7670
Carl Canard

Yel S R L 500

Cangallo 1454
Piso 8 of -41 (1037)
Buenos Aries, Argentina

Investigation at Saronix is continuing in an effort to fully identify the customers which may have received the NYMPH NYPO 49-12 crystal from the date that the vinyl wrapping process began, until September, 1986.

Investigation at Signetics Company, Sunnyvale, California, has determined that the integrated circuit chips (HEF 4001 BT, HEF 4093 BT, HEF 4518 BT AND HEF 4521 BT) were manufactured by N V Phillips, headquartered in Eindhoven, Holland, The Netherlands. N V Phillips is the parent company for North American Phillips. These chips, known as "Hefer" (PH) 4000 series, or jellybean chips, are fabricated in a plant near Eindhoven, Holland, and sent to Taiwan for assembly. The "B" designator in the reference number of the chip, refers to the product line. The "T" designator in the reference number labels the chip as a "mini package". N V Phillips produces approximately 150 million of this series of chip, for world wide distribution, each year. Approximately 10 million of these chips are sold in the United States, each year, at a cost ranging between $1.37 and $2.05 each.

definition of components
+ distributor extracted for
Research production Team - (Dr Brown)
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