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NATIONAL TRANSPORTATION SAFETY COMMITTEE

Safety Investigation Report

Electrical Failure
Soekarno-Hatta International Airport
Tangerang, Banten
Republic of Indonesia

16 December 2012

NATIONAL TRANSPORTATION SAFETY COMMITTEE
MINISTRY OF TRANSPORTATION
REPUBLIC OF INDONESIA
2013

This Final Report was produced by the National Transportation Safety Committee (NTSC), 3rd Floor Ministry of Transportation, Jalan Medan Merdeka Timur No. 5 Jakarta 10110, Indonesia.

The report is based upon the investigation carried out by the NTSC in accordance with Annex 13 to the Convention on International Civil Aviation Organization, the Indonesian Aviation Act (UU No. 1/2009) and Government Regulation (PP No. 3/2001).

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ABBREVIATIONS AND DEFINITIONS

ACC	:	Area Control Center
ATC	:	Air Traffic Control
ATS	:	Air Trafic Services
C	:	Celsius
CNS	:	Communication, Navigation and Surveillance
DC	:	Direct Current
FIR	:	Flight Information Region
IGBT	:	Insulation Gate Bipolar Transistors
JAATS	:	Jakarta Automated Air Traffic System
KNKT/NTSC	:	*Komite Nasional Keselamatan Transportasi* (National Transportation Safety Committee)
kVa	:	Killo Volt Ampere
PLN	:	*Perusahaan Listrik Negara* (Indonesian State Electricity Company)
UPS	:	Uninterruptible Power Supplies
UTC	:	Coordinated Universal Time

INTRODUCTION

SYNOPSIS

On Sunday 16 December 2012 at 1655 Local Time or 0955 UTC, the Air Traffic Control System of the Soekarno-Hatta International Airport, Jakarta (WIII) had electrical power supply failure. It caused radar display on Jakarta Automated Air Traffic System (JAATS) could not display neither aircrafts target nor flight plan information and some of the ground to air radio communication was failure.

The Air Traffic Controller used a procedural (non-radar) control to manage the traffic as a safety contingency procedure. They delayed 21 aircrafts to depart from Jakarta, gave 18 arriving aircrafts to land as a first priority by re-arranged the safe separation between the aircrafts using non radar separation, two arriving aircraft diverted to Ahmad Yani International Airport, Semarang (WARS), one aircraft returned to the Hussein Sastranegara International Airport, Bandung (WIIB) and 22 aircrafts delayed to depart from their departure airport.

The occurrence was detected by the electrical technician when the display monitor at the first floor was quit, the electrical technician went to the second floor to indentify and taking action by selecting the distribution selector manually selected to the UPS 2. At the time of action the UPS room was smoky.

The electrical power supply failure could be recovered at 1010 UTC by switched the Uninterruptible Power Supplies (UPS) 1 to UPS 2 by selected the bypass switch manually.

There were no reported any aircraft near miss or collision during the occurrence.

The electrical power failed to supply the main distribution panel, due to the UPS 1 failed transferring electrical power to the UPS 2. It caused by the capacitors at one of UPS inverter exploded and the debris shorted the automatic distribution control switching system.

The investigation conducted a functional check of the three capacitors at the same module of the exploded capacitors. The capacitance value from the one of them was 2 micro-farad, it degraded significantly meanwhile the standard value of the capacitance is 2,200 micro-farad.

The current maintenance tasks or check lists that used in Soekarno-Hatta International Airport to maintain and support the operation worthiness of the UPS did not contain of any items to detect the degradation of capacitors, rectifiers and temperature sensors.

As a result of this investigation, the NTSC issued a safety recommendation to the Directorate General of Civil Aviation and Soekarno-Hatta International Airport, Jakarta to address safety issues identified in this report.

1 FACTUAL INFORMATION

1.1 History of the Occurrence

On 16 December 2012, at 0030 UTC[1], the electrical technician of the Soekarno-Hatta International Airport, Jakarta[2] (WIII) conducted daily inspection on both of the Uninterruptible Power Supplies (UPS) and the UPSs in a good condition.

At 0955 UTC, the monitor display which used to monitor the central air conditioning (chiller) located on first floor at electrical building suddenly off. At the same time, the radar displays on all sectors were suddenly off and some of the ground to air radios communication on the Jakarta Area Control Center (ACC) were off.

The electrical technician went to the second floor to check the UPS number 1 (UPS 1), he founded that the UPS room was smoky with burned smell and the UPS 1 was off. The technician switched the electrical power from the UPS 1 to the UPS 2 using manual selector.

While the electrical supplies failed, the Jakarta Air Traffic Controller (ATC) managing the air traffic with procedural (non-radar) control as a safety contingency procedure.

They delayed 21 aircrafts departure from Jakarta, gave priority 18 arriving aircrafts to land by re-arranged the safe separation between aircrafts using non radar separation, two arriving aircraft diverted to Ahmad Yani International Airport, Semarang (WARS), one aircraft returned to the Hussein Sastranegara International Airport, Bandung (WIIB) and 22 aircrafts delayed to depart from their departure airport.

At 1010 UTC the electrical power supply recovered and the ATS system restarted.

At 1106 UTC the ATS system recovered, the non radar service changed to radar service. During transition, departure aircrafts was given a radar separation and arrival aircrafts was given 5 minutes interval separation.

At 1400 UTC the ATS operated normally.

There were no reported any aircraft near miss or collision during the occurrence.

1 The 24-hours clock in Coordinated Universal Time (UTC) is used in this report to describe the local time as specific events occured. Local time is UTC+7 hours.

2 Soekarno-Hatta International Airport will be named as Jakarta for the purpose of this report.

Figure 1: The UPS 1

1.2 Injuries to Persons

There were no injuries to persons as a result of this occurrence.

1.3 Damage to Aircraft

The damage of the UPS number 1 was found as follows:

- Two of five capacitors exploded on one of the inverter;
- Two Insulation Gate Bipolar Transistors (IGBT) burned and exploded;
- The exploded debris capacitors materials mostly accumulated at the inverter control system, and shorted the bus bar to ground;
- Plastic that covered the inverter module was melted.

Figure 2: The capacitors

Figure 3: The Insulation Gate Bipolar Transistors (IGBT)

Figure 4: The capacitor materials debris at the inverter control system bus bar

Figure 5: The inverter control terminal after cleaned from debris

Figure 6: The melted plastic cover

1.4 Other Damage

Not relevant to this occurrence.

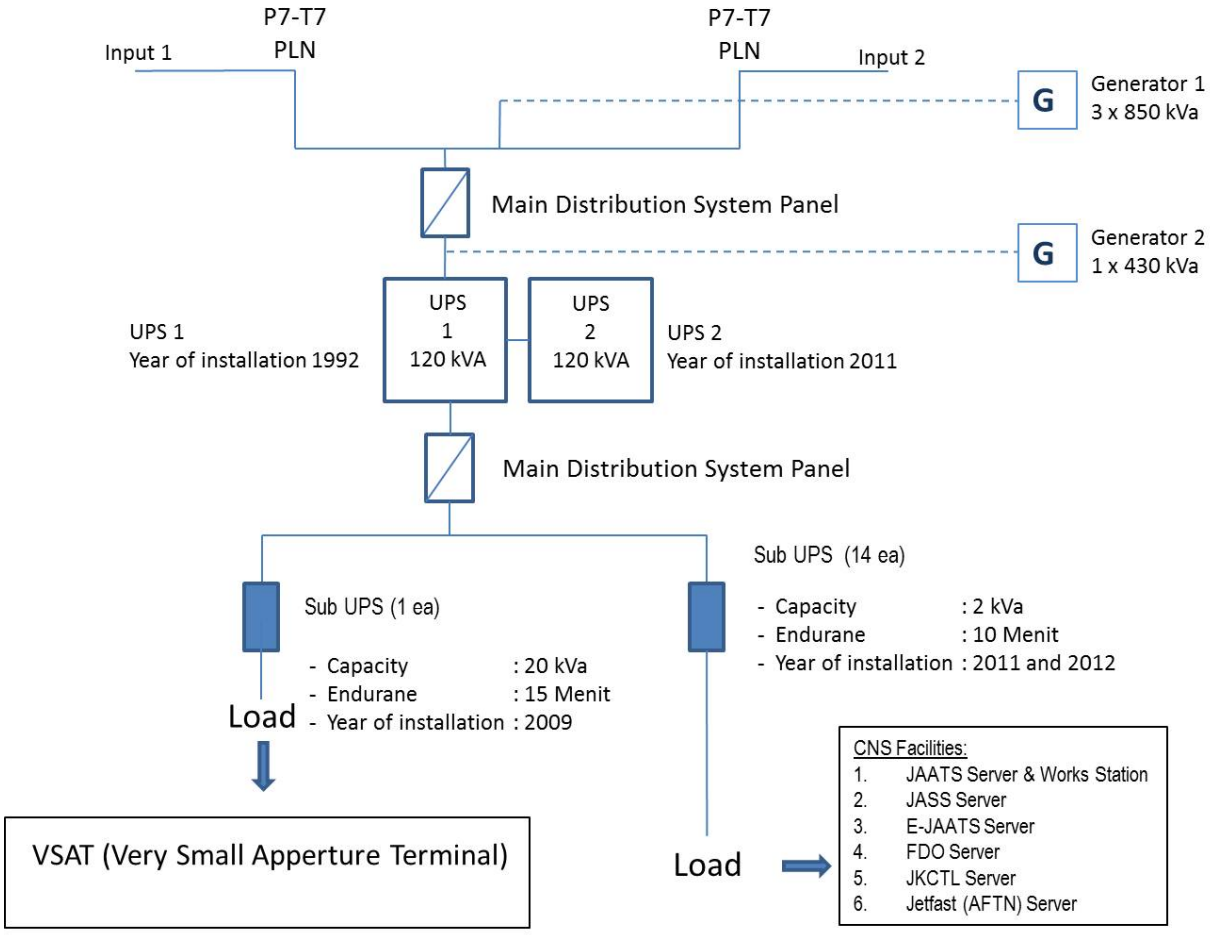
1.5 Personnel Information

Not relevant to this occurrence.

1.6 UPS Information

UPS 1

Country of Manufacturer	:	France
Manufacturer	:	Socomec
Type/ Model	:	A2S. 3047
Serial Number	:	AFF 5796
Year of Installation	:	1992
Capacity	:	120 kVa
Endurance	:	2 hours



The failure UPS (UPS 1) replaced by UPS 2, and UPS 2 replaced by a spare UPS with same capacity (120 kVa). The UPSs was arranged in series.

1.7 Meteorological Information

Not relevant to this occurrence.

1.8 Aids to Navigation

There were no reported any malfunction or failure of the aids to navigation.

1.9 Communications

Some of the ground to air radios communication on Jakarta Area Control Centre (ACC) were off for about 15 minutes, the communication taken over by the other sector. Meanwhile the radio Communication on Jakarta Approach and Tower Control performed normally.

1.10 Aerodrome Information

Airport Name	:	Soekarno-Hatta International Airport
Airport Certificate	:	003/SBU-DBU/VII/2010
Airport Identification	:	WIII
Coordinate	:	06° 07’25” S 106°39’40”E
Airport Operator	:	PT. Angkasa Pura II (Persero)

1.11 Flight Recorders

Not relevant to this occurrence.

1.12 Wreckage and Impact Information

Not relevant to this occurrence.

1.13 Medical and Pathological Information

Not relevant to this occurrence.

1.14 Fire

There were any sparking carbons marked at the cabinet and investigation also found the dielectric debris shorted at the inverter control bus bar.

1.15 Survival Aspects

Not relevant to this occurrence.

1.16 Tests and Research

1.16.1 Component investigation

The investigation conducted a functional check of the three capacitors at the same module of the exploded capacitors. The capacitance value from the one of them was 2 micro-farad, it degraded significantly meanwhile the standard value of the capacitance is 2,200 micro-farad.

Figure 7: Capacitor functional check

Refer to the manufacture's operating manual, the maximum operating temperature sensor is 80°C. The investigation tested the sensor starting from room temperature up to 160°C and there was no indication of the sensor's function.

1.17 Organizational and Management Information

PT. Angkasa Pura II is the State-Owned Enterprises engaging in airport and Air Traffic Services in Western Indonesia. Angkasa Pura II managed 12 Airports, including the Soekarno-Hatta International Airport, Jakarta.

The Soekarno-Hatta International Airport conducted an air traffic services for air traffic operated on the Jakarta Flight Information Region (FIR).

Figure 8: Jakarta FIR

1.18 Additional Information

1.18.1 The Electrical Power Operation

- The main electrical input power from *PT. Perusahaan Listrik Negara* (PLN)[3] was normal average of 20 kV and 50 Hz (figure 14).
- Remaining battery voltage was 380 V.
- Battery uses on electrical back up were sulfur lead acid sealed batteries.
- The operating temperature of temperature sensor is 80°C (ref Manufacture Operating Manual page 6, item 3.2 Alarm A-1).

3 PT. Perusahan Listrik Negara also known as State Electricity Company.

Date/Time	Current A	Current B	Current C	Apparent Energy	Reactive Energy	Real Energy	Frequency	Power Factor Total	Apparent Power Total	Reactive Power Total	Real Power Total	Voltage A-B	Voltage B-C	Voltage C-A
16/12/2012 16:51:31	734,0	751,0	741,0	416347312,1	180839659,7	374389508,5	49,97	0,9040	25910,0	11100,0	23410,0	20080,0	20240,0	20140,0
16/12/2012 16:51:32	734,0	751,0	741,0	416347319,0	180839662,6	374389514,7	49,98	0,9040	25900,0	11090,0	23410,0	20080,0	20230,0	20140,0
16/12/2012 16:51:33	734,0	751,0	741,0	416347326,0	180839665,6	374389521,0	49,98	0,9040	25910,0	11090,0	23420,0	20080,0	20240,0	20140,0
16/12/2012 16:51:34	735,0	752,0	742,0	416347339,8	180839671,5	374389533,5	49,99	0,9040	25920,0	11090,0	23430,0	20080,0	20240,0	20140,0
16/12/2012 16:51:35	734,0	751,0	741,0	416347346,7	180839674,5	374389539,7	50,00	0,9040	25910,0	11080,0	23420,0	20090,0	20240,0	20140,0
16/12/2012 16:51:36	734,0	752,0	742,0	416347353,6	180839677,4	374389546,0	50,01	0,9040	25920,0	11080,0	23440,0	20090,0	20240,0	20140,0
16/12/2012 16:51:37	733,0	751,0	741,0	416347360,5	180839680,4	374389552,2	50,01	0,9040	25880,0	11070,0	23400,0	20080,0	20240,0	20140,0
16/12/2012 16:51:38	734,0	751,0	741,0	416347367,4	180839683,3	374389558,4	50,02	0,9040	25890,0	11060,0	23410,0	20080,0	20240,0	20140,0
16/12/2012 16:51:39	734,0	751,0	741,0	416347374,3	180839686,3	374389564,7	50,02	0,9040	25890,0	11060,0	23410,0	20080,0	20230,0	20140,0
16/12/2012 16:51:40	734,0	751,0	741,0	416347381,2	180839689,2	374389570,9	50,03	0,9040	25890,0	11060,0	23410,0	20090,0	20240,0	20140,0
16/12/2012 16:51:41	735,0	752,0	742,0	416347388,1	180839692,1	374389577,2	50,03	0,9050	25920,0	11050,0	23450,0	20090,0	20230,0	20140,0
16/12/2012 16:51:42	735,0	751,0	741,0	416347395,0	180839695,1	374389583,4	50,03	0,9050	25920,0	11050,0	23440,0	20080,0	20240,0	20140,0
16/12/2012 16:51:43	736,0	752,0	743,0	416347401,9	180839698,0	374389589,7	50,03	0,9050	25950,0	11060,0	23480,0	20080,0	20230,0	20140,0
16/12/2012 16:51:44	735,0	751,0	742,0	416347408,9	180839701,0	374389595,9	50,03	0,9050	25920,0	11050,0	23440,0	20080,0	20230,0	20140,0
16/12/2012 16:51:45	734,0	751,0	741,0	416347415,8	180839703,9	374389602,2	50,03	0,9040	25890,0	11040,0	23420,0	20080,0	20230,0	20130,0
16/12/2012 16:51:46	734,0	751,0	741,0	416347422,7	180839706,9	374389608,4	50,03	0,9040	25900,0	11050,0	23420,0	20080,0	20230,0	20130,0
16/12/2012 16:51:47	735,0	751,0	742,0	416347429,6	180839709,8	374389614,7	50,04	0,9040	25920,0	11050,0	23450,0	20080,0	20240,0	20140,0
16/12/2012 16:51:48	734,0	751,0	741,0	416347436,5	180839712,7	374389620,9	50,04	0,9040	25900,0	11050,0	23420,0	20080,0	20240,0	20140,0
16/12/2012 16:52:00	736,0	752,0	743,0	416347512,5	180839745,1	374389689,7	50,07	0,9050	25960,0	11040,0	23490,0	20090,0	20240,0	20150,0
16/12/2012 16:53:00	733,0	750,0	740,0	416347940,2	180839927,6	374390076,5	50,00	0,9030	25870,0	11130,0	23350,0	20080,0	20240,0	20140,0
16/12/2012 16:54:00	738,0	756,0	747,0	416348375,6	180840113,5	374390470,1	50,08	0,9050	26080,0	11080,0	23610,0	20090,0	20240,0	20140,0
16/12/2012 16:55:00	736,0	753,0	744,0	416348811,5	180840299,6	374390864,1	50,10	0,9050	25980,0	11070,0	23510,0	20090,0	20240,0	20140,0
16/12/2012 16:56:00	731,0	750,0	740,0	416349238,6	180840482,3	374391250,2	49,97	0,9030	25840,0	11100,0	23340,0	20090,0	20240,0	20140,0
16/12/2012 16:57:00	731,0	749,0	740,0	416349672,7	180840668,2	374391642,5	50,04	0,9040	25830,0	11050,0	23340,0	20090,0	20240,0	20150,0
16/12/2012 16:58:00	730,0	747,0	738,0	416350099,3	180840850,0	374392028,3	49,99	0,9040	25780,0	11040,0	23300,0	20090,0	20240,0	20140,0
16/12/2012 16:59:00	727,0	744,0	735,0	416350531,8	180841034,1	374392419,7	50,06	0,9050	25690,0	10920,0	23260,0	20100,0	20250,0	20150,0
16/12/2012 17:00:00	726,0	744,0	734,0	416350970,2	180841221,6	374392803,6	50,12	0,9040	25660,0	10960,0	23220,0	20100,0	20250,0	20160,0
16/12/2012 17:01:00	737,0	755,0	745,0	416351392,6	180841403,5	374393197,1	50,09	0,9030	26040,0	11210,0	23500,0	20080,0	20240,0	20140,0
16/12/2012 17:02:00	739,0	756,0	747,0	416351830,1	180841590,3	374393592,7	50,08	0,9040	26100,0	11160,0	23590,0	20080,0	20240,0	20140,0
16/12/2012 17:03:00	734,0	751,0	742,0	416352260,3	180841774,4	374393981,4	50,08	0,9040	25920,0	11100,0	23430,0	20090,0	20240,0	20140,0
16/12/2012 17:04:00	737,0	753,0	744,0	416352696,2	180841961,1	374394375,3	50,03	0,9030	26000,0	11150,0	23490,0	20090,0	20240,0	20140,0
16/12/2012 17:05:00	739,0	756,0	748,0	416353125,8	180842145,0	374394763,6	50,08	0,9030	26100,0	11200,0	23580,0	20080,0	20230,0	20140,0
16/12/2012 17:06:00	735,0	753,0	743,0	416353563,8	180842332,2	374395159,4	50,17	0,9040	25980,0	11090,0	23490,0	20090,0	20240,0	20150,0
16/12/2012 17:07:00	735,0	753,0	743,0	416353992,8	180842515,6	374395547,2	50,05	0,9040	25970,0	11130,0	23470,0	20090,0	20240,0	20140,0
16/12/2012 17:08:00	738,0	756,0	747,0	416354429,0	180842701,5	374395941,8	50,11	0,9040	26080,0	11140,0	23580,0	20080,0	20240,0	20140,0
16/12/2012 17:09:00	740,0	756,0	747,0	416354866,6	180842887,7	374396337,8	50,17	0,9050	26120,0	11090,0	23640,0	20090,0	20250,0	20150,0
16/12/2012 17:10:00	743,0	759,0	750,0	416355304,5	180843073,9	374396734,0	50,10	0,9050	26200,0	11160,0	23700,0	20080,0	20230,0	20140,0
16/12/2012 17:11:00	742,0	759,0	749,0	416355736,8	180843257,9	374397125,2	50,11	0,9050	26180,0	11160,0	23680,0	20070,0	20230,0	20130,0
16/12/2012 17:12:00	747,0	765,0	755,0	416356177,0	180843445,9	374397523,2	50,12	0,9040	26360,0	11250,0	23840,0	20070,0	20220,0	20130,0
16/12/2012 17:13:00	750,0	769,0	758,0	416356612,8	180843632,6	374397917,0	50,13	0,9030	26480,0	11380,0	23910,0	20070,0	20220,0	20130,0
16/12/2012 17:14:00	751,0	768,0	759,0	416357057,1	180843822,6	374398318,6	50,11	0,9050	26480,0	11270,0	23960,0	20060,0	20220,0	20120,0
16/12/2012 17:15:00	754,0	771,0	762,0	416357509,2	180844015,6	374398714,5	50,06	0,9030	26570,0	11380,0	24010,0	20060,0	20210,0	20110,0
16/12/2012 17:16:00	756,0	774,0	766,0	416357940,8	180844199,6	374399117,7	50,14	0,9050	26700,0	11350,0	24170,0	20070,0	20220,0	20120,0
16/12/2012 17:17:00	757,0	775,0	766,0	416358389,0	180844390,9	374399523,0	50,05	0,9040	26710,0	11420,0	24140,0	20060,0	20210,0	20110,0
16/12/2012 17:18:00	762,0	781,0	772,0	416358831,1	180844580,2	374399922,5	50,07	0,9040	26880,0	11520,0	24290,0	20040,0	20190,0	20100,0
16/12/2012 17:19:00	765,0	783,0	774,0	416359282,4	180844774,2	374400330,0	50,12	0,9030	26970,0	11580,0	24360,0	20050,0	20200,0	20100,0

Figure 9: The PT. PLN electric main power input data

1.18.2 Configuration and installation

a. The UPS 1 located at the second floor, the control room and the UPS 2 located at the first floor;

b. Alarm signal were not available on the operating control room, the only alarm/warning signal was at the UPS unit;

c. The UPS 1 used a static and mechanical By-pass.

d. ICAO Doc 9157 para 2.3.4. Uninterruptible Power Supply (UPS) System;

Sub para 2.3.4.1. The UPS Equipment. The uninterruptible electric power supply is necessary for electronic or other equipment that performs a critical function and require continuous, disturbance free electrical power to operate properly.

Sub para 2.3.4.2. UPS Equipment. Uninterruptible Power Supply (UPS) system consist of one or more UPS modules, an energy storage battery, and accessories as required to provide a reliable and high quality power supply. The UPS system isolates the load from the primary and secondary sources and in the event of a power interruption provides regulated power to the critical load for a specified period (the battery typically has a 15 minutes capacity when operating at full load).

a) ***UPS Module****. A UPS module is the static power conversion portion of the UPS system and consists of a rectifier, an inverter, and associated control along with the synchronizing, protective and auxiliary device. UPS modules may be designed to operate individually or in parallel.*

b) ***Redundancy****. A redundant UPS system is suitable for most operation. However if the expense is justified, a redundant UPS configuration (see figure 2-3 or figure 12 in this report) may be used to protect against module failure or very frequent primary power failures.*

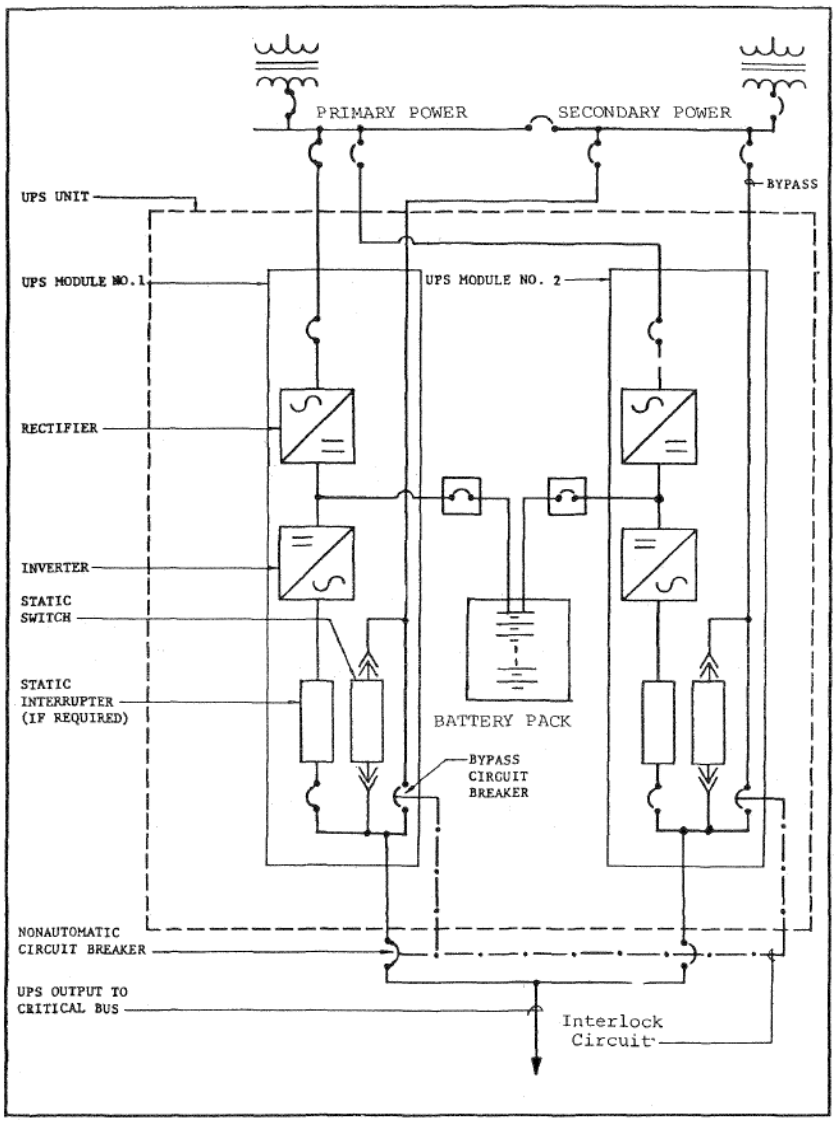


Figure 10: Typical UPS standby redundant configuration

c) ……

d) Remote Alarm. The UPS equipment should be equipped with a remote-alarm panel to be installed in the operating space served by UPS unit or in another continuously occupied room, such as a guard office. Since UPS rooms are usually unattended, additional remote indicating device should be provided to monitor the environmental control and fire alarm of UPS module and battery rooms.

e) ……

f) ……

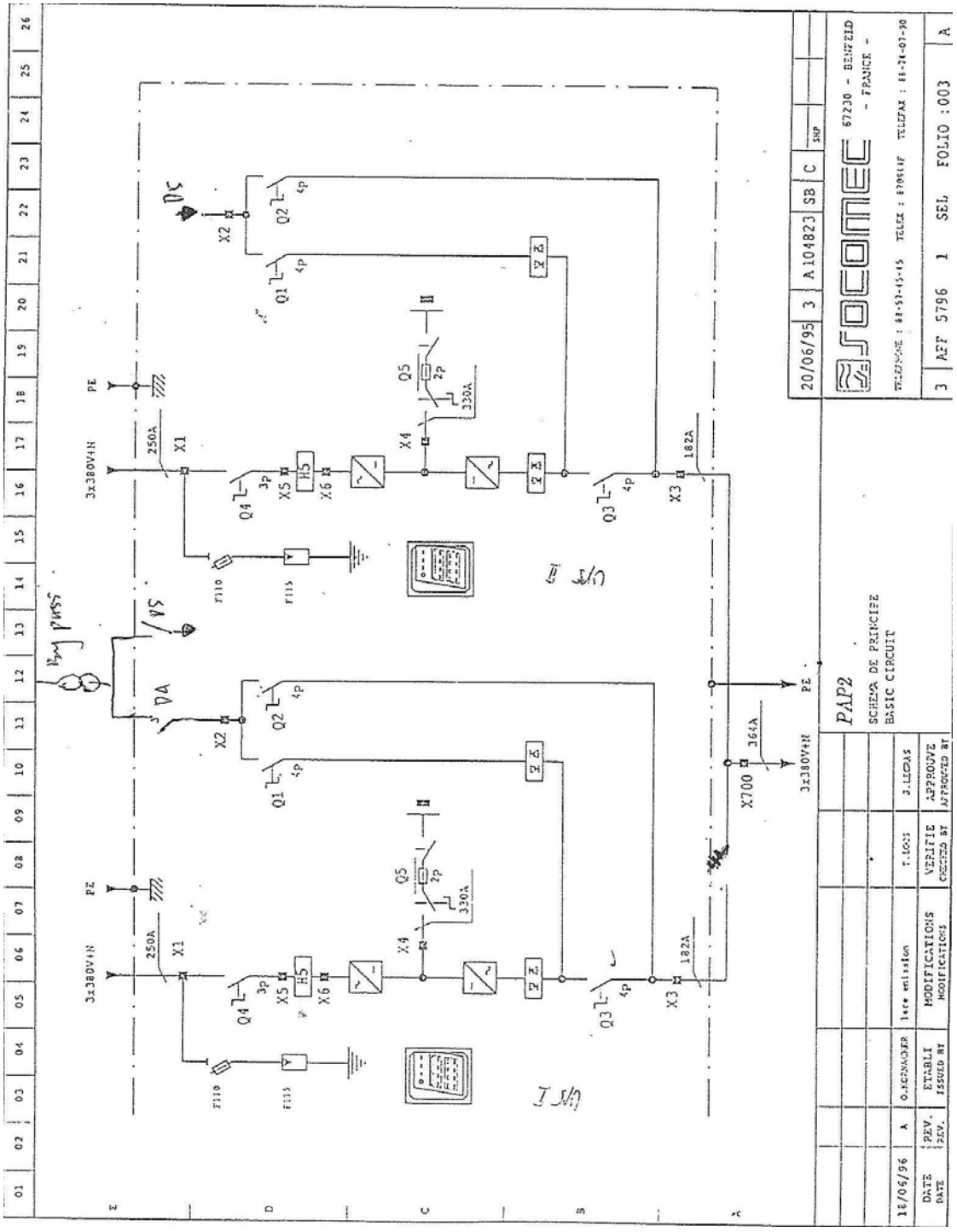


Figure 11: Basic circuit scheme of the Socomac UPS

1.18.3 Maintenance

a. The daily maintenance of UPS performed by Soekarno-Hatta International Airport and the higher maintenance was contracted to the contractor, the maintenance checklist mostly referred to the Director General of Civil Aviation decree number SKEP/157/IX/2003. The maintenance tasks as mention on the checklist were as follows:
   - Functional check the voltage, ampere, and frequency of UPS input and output;
   - Functional check voltage, ampere and frequency of rectifier input;
   - Check the floating voltage;
   - Check total batteries voltage and individual battery cell;
   - Inspect electrical cable;
   - Inspect water level and physical condition of the battery;
   - Add the water level;
   - Clean external battery;
   - Maxi and mini protection test;
   - Clean the room surrounding the equipment.

   The checklist was not met to the requirement of inspection and recording of UPS operating temperature as mandated by the SKEP/157/IX/2003 Subject "*Maintenance and Reporting Guidelines for Aviation Electronic and Electrical equipment*" or the manufacturer requirement.

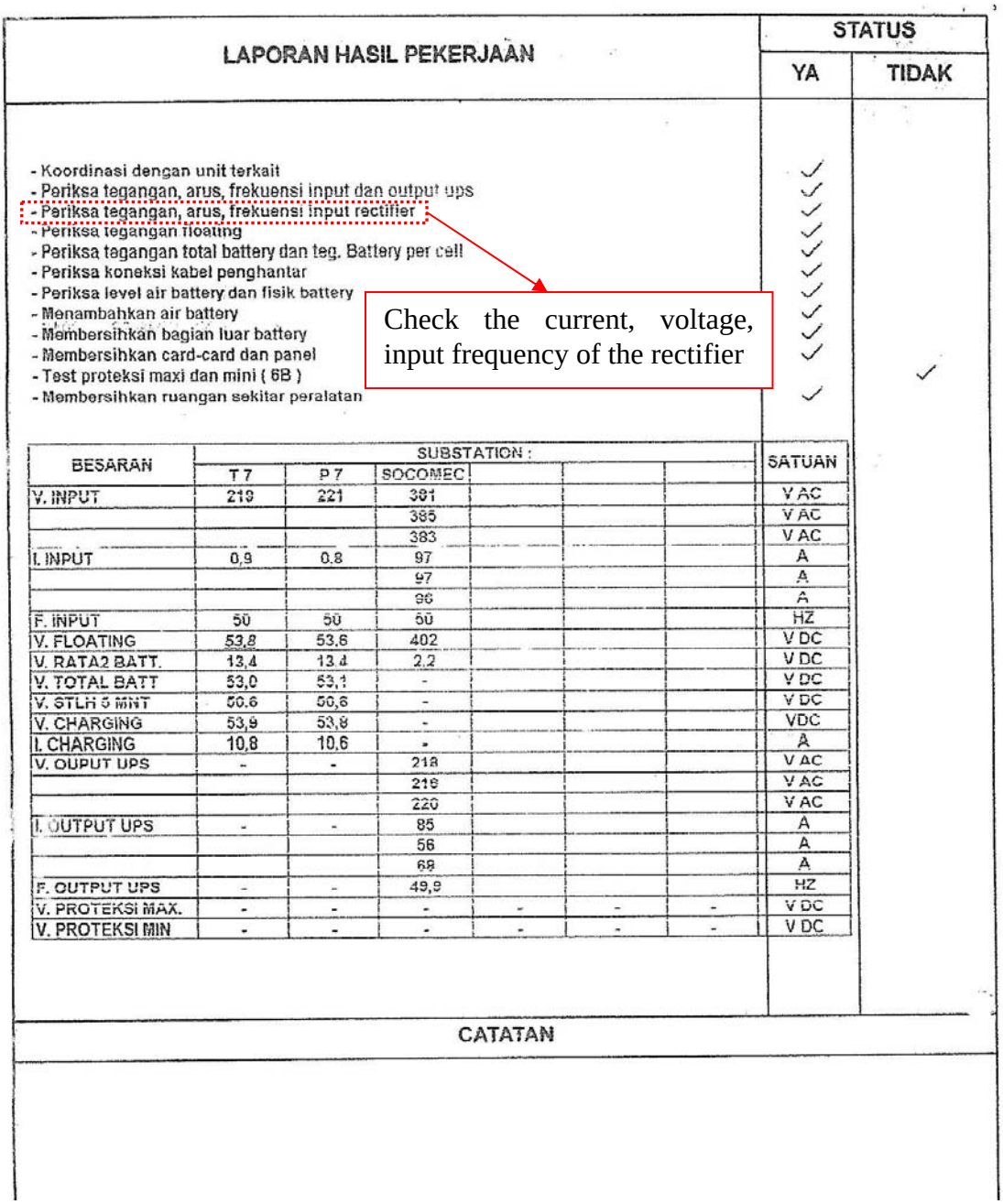
b. Refer from document V009.DOC Test and Check List of the ST 45-200 kVa – rev 00 (06/06/93) of the UPS 1 manufacture stated:

   The instruction number 8: General checks to be carried out with no load on the UPS.

   Close the mains supply switch, wait until Led L1 on the control panel lights up, reset the alarms from the control panel (to cancel any alarms that may be in memory) and with the UPS running at no load carry out the following checks and settings:

   - *Check that the DC Voltage at the rectifier bridge does not differ more than 2 V between inverter ON and inverter OFF.*

c. The UPS three monthly inspection report dated on 12 November 2012, showed that the rectifier functional check was only rectifier input check (figure 13).



LAPORAN HASIL PEKERJAAN

STATUS

	YA	TIDAK
- Koordinasi dengan unit terkait	✓	
- Periksa tegangan, arus, frekuensi input dan output ups	✓	
- Periksa tegangan, arus, frekuensi input rectifier	✓	
- Periksa tegangan floating	✓	
- Periksa tegangan total battery dan teg. Battery per cell	✓	
- Periksa koneksi kabel penghantar	✓	
- Periksa level air battery dan fisik battery	✓	
- Menambahkan air battery	✓	
- Membersihkan bagian luar battery	✓	
- Membersihkan card-card dan panel	✓	
- Test proteksi maxi dan mini (6B)		✓
- Membersihkan ruangan sekitar peralatan	✓	

Check the current, voltage, input frequency of the rectifier

BESARAN	SUBSTATION : T7	P7	SOCOMEC				SATUAN
V. INPUT	219	221	381				V AC
			385				V AC
			383				V AC
I. INPUT	0,9	0,8	97				A
			97				A
			96				A
F. INPUT	50	50	50				HZ
V. FLOATING	53,8	53,6	402				V DC
V. RATA2 BATT.	13,4	13,4	2,2				V DC
V. TOTAL BATT	53,0	53,1	-				V DC
V. STLH 5 MNT	50,6	50,6	-				V DC
V. CHARGING	53,9	53,8	-				VDC
I. CHARGING	10,8	10,6	-				A
V. OUPUT UPS	-	-	218				V AC
			219				V AC
			220				V AC
I. OUTPUT UPS	-	-	85				A
			56				A
			69				A
F. OUTPUT UPS	-	-	49,9				HZ
V. PROTEKSI MAX.	-	-	-	-	-	-	V DC
V. PROTEKSI MIN	-	-	-	-	-	-	V DC

CATATAN

Figure 12: The UPS three monthly report

The investigation did not found the procedure and interval to check the degradation of capacitor.

1.19 Useful or Effective Investigation Techniques

The investigation was conducted in accordance with the NTSC approved policies and procedures, and in accordance with the standards and recommended practices of Annex 13 to the Chicago Convention.

2 ANALYSIS

Component inspection of the three capacitors at the same module to the exploded capacitors was found a significant degradation, one of them was 2 microfarad deviated from the standard of 2,200 microfarad.

The rectifier functional check was only the rectifier input check while the DC voltage at the rectifier bridge between inverter on and inverter off were not included (differ more than 2 V) the degradation of the rectifier were not detected.

Since installation on 1992 up to the occurrence it was 20 years operation, the investigation did not find any replacement of rectifier, it might degraded the function or failed to convert the alternating current to direct impulse current, caused the battery power supplied a high direct current to the capacitors and the weakest one exploded and also burned the Insulation Gate Bipolar Transistors (IGBT).

The exploded material sprayed through to the inverter control system and sorted the bus bar to ground caused the system failed transferring the electrical power from UPS 1 to UPS2.

Degradation of the capacitors could be detected by an inspection using capacitance meter in certain interval a replace as necessary to prevent the failure.

The UPS current maintenance task used by the Soekarno-Hatta International Airport included Director General of Civil Aviation degree SKEP/157/IX/2003, subject "*Maintenance and Reporting Guidelines for Aviation Electronic and Electrical equipment*" would not sufficient to support operation worthiness of the UPS.

An additional inspection of temperature sensor located at the same phase of inverter found that the sensor was not function normally. Temperature test on room temperature up to 160°C, sensor did not operate and this condition also might cause the control system failed to detect the power system problem.

3 CONCLUSIONS

3.1 Findings

a. The daily inspection at the day of occurrence was reported normal.
b. There were two capacitors exploded.
c. The dielectric capacitance debris shorted the switching control system circuit.
d. The remaining capacitance value on the one of capacitors degraded significantly (2 micro-farad).
e. The maintenance check and interval to detect the capacitor degradation was not included on the check list.
f. The maintenance check of the DC voltage at the rectifier bridge differences between inverter ON and inverter OFF, was tested on the inverter ON condition only.
g. The maintenance check of the Temperature Sensor was not included on the check list.
h. The manufacture manual and the regulator requirement (the Director General of Civil Aviation decree number SKEP/157/IX/2003) were partially performed.
i. The UPS configuration installation was in series.

3.2 Causes/Factors[4]

a. The switching control system failed to transfer the electrical power from UPS 1 to the UPS 2 automatically, due to the dielectric materials of the exploded capacitors sprayed to the switching unit bus bar shorted circuit to ground.

b. The degraded capacitors could not store and protect a very high Direct Current (DC) which flowed from the battery system, and passing it through the degraded capacitors and the Insulation Gate Bipolar Transistors (IGBT) when the rectifier fail to maintain the DC supply to the battery system. It caused the degraded capacitors and the IGBT exploded.

c. The current maintenance tasks or check lists that used to maintain and support the operation worthiness of the UPS did not contain of any items to detect the degradation of capacitors, rectifiers and temperature sensors.

4 "Factors" is defined as events that might cause the occurrence. In the case that the event did not occur then the accident might not happen or result in a less severe occurrence.

4 SAFETY ACTION

At the time of issuing this final investigation report, the National Transportation Safety Committee had been informed of safety actions resulting from this occurrence.

4.1 Soekarno-Hatta International Airport

a. Provided one additional generator with capacity 430 kVa.

b. Conducted initial installation of the new UPS with capacity 200 kVa.

c. Installed additional independent UPS with capacity 2 kVa on every JAATS working station and voice communication equipment with 15 minutes endurance.

d. Installed UPS alarm system on the electrical operating control room.

e. Conducted an inventory equipment lifetime of all Communication, Navigation and Surveillance (CNS).

f. Reviewed the configuration of the electrical system related to CNS.

5 SAFETY RECOMMENDATIONS

As a result of this investigation, the National Transportation Safety Committee issued safety recommendations to address safety issues identified in this report.

5.1 Soekarno-Hatta International Airport

To prevent the same occurrence on the future, the Soekarno-Hatta International Airport should:

a. Proposed the UPS Maintenance Program to the Directorate General of Civil Aviation in order to meet the manufacture and regulatory requirement, including addition functional check of the capacitor, rectifier and temperature sensor.

b. Review the location of the capacitor to be desegregated to the switching control system.

c. Review the configuration of the UPS transfer protection to be met the requirement of the ICAO Doc 9157-AN/901 Aerodrome Design Manual Part 5 Electrical System, sub para 2.3.4.2.

d. Review the location of operating control room and UPS room to be in one floor level, to make more quick and safe action whenever required operator action to solve any problem in the UPS system.

5.2 Directorate General of Civil Aviation, Directorate of Airport

To prevent the same occurrence on the future, the Directorate General of Civil Aviation, Directorate of Airport should:

a. Review and revise the Director General Degree SKEP/157/IX/2003 Subject "*Maintenance and Reporting Guidelines for Aviation Electronic and Electrical equipment*" to ensure that the UPS system maintenance at all airport electrical system have met the manufacture and regulatory requirement.

b. Review the UPS configuration and operating requirement to meet the ICAO Doc 9157-AN/901 Aerodrome Design Manual Part 5 Electrical System.