

FINAL INVESTIGATION REPORT



**SERIOUS INCIDENT – ENGINE FIRE PIAC FLIGHT PK-743,
B777-200ER REG NO AP-BMH AT JINNAH INTERNATIONAL
AIRPORT, KARACHI ON 02ND DECEMBER, 2023**

SCOPE

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ABBREVIATIONS

| | |
|--------------|--|
| AMM | Aircraft Maintenance Manual |
| ATC | Air Traffic Controller |
| ATPL | Air Transport Pilot License |
| BASIP | Bureau of Aircraft Safety Investigation Pakistan |
| FCOM | Flight Crew Operating Manual |
| ft | Feet |
| h | Hour(s) |
| HP | High-Pressure |
| ICAO | International Civil Aviation Organization |
| IOU | Incident And Occurrence Unserviceability |
| JIAP | Jinnah International Airport |
| kt | Knots |
| LM | Line Maintenance |
| PAA | Pakistan Airports Authority |
| PIA | Pakistan International Airline |
| s | Second (s) |
| UTC | Universal Time Coordinated |
| WBH | Wide Body Hanger |
| PRSOV | Pressure Regulating and Shutoff Valve |
| HPSOV | High-Pressure Shutoff Valve |
| HPFAC | High pressure Fan Air Check |

INTRODUCTION

This serious incident was reported to Bureau of Aircraft Safety Investigation Pakistan (BASIP) by Pakistan Airports Authority (PAA) vide Incident Occurrence and Unserviceability (IOU) Report. The serious incident was notified to International Civil Aviation Organization (ICAO) in line with Annex-13. The investigation has been conducted by BASIP.

SYNOPSIS

On 2nd December, 2023, serious incident, engine fire occurred in Pakistan International Airline (PIA), flight No. PK-743, B777-200ER aircraft, Registration No. AP-BMH, (Sector KHI – MED), at Jinnah International Airport (JIAP), Karachi.

PK-743, a scheduled commercial passenger flight, departed from JIAP, Karachi, bound for Prince Mohammad bin Abdul Aziz International Airport, Madinah. During the climb phase at approximately 300 feet (ft) Above Ground Level (AGL), the right engine experienced an overheat condition, immediately followed by the activation of the fire warning system. The flight crew declared an emergency due to an in-flight fire indication and promptly initiated the fire suppression procedures. Following the apparent extinguishment of the fire, the crew returned the aircraft to JIAP, Karachi and landed safely.

Detailed investigation revealed an HP duct being disconnected due to its clamp getting loose subsequently resulting in the hot air leak. The hot air leakage initiated the engine fire warning. Engine and aircraft were inspected as per aircraft publications and were later released for operations after required rectification of the observed anomaly.

SECTION 1 - FACTUAL INFORMATION

1.1. History of the flight

1.1.1. On 2nd December, 2023, serious incident, engine fire occurred in PIA flight No. PK-743, B777-200ER aircraft, Registration No. AP-BMH at JIAP, Karachi.

1.1.2. At 000400, while in the climb phase from JIAP, the flight crew transmitted a "MAYDAY MAYDAY" call to ATC with reporting an engine fire. Immediate emergency procedures were initiated onboard the aircraft

1.1.3. At 000457, the flight crew informed ATC that the immediate threat had been mitigated, subsequently downgrading the emergency status from "MAYDAY" to "PAN PAN." The aircraft then proceeded to execute an emergency return to JIAP, Karachi.

1.1.4. At 002000 h, PK-743 landed safely back at JIAP, Karachi.

1.2. Injuries to person(s)

1.2.1. No injury was reported to any person on board the aircraft.

| Injuries | Crew | Passengers | Total in aircraft | Others |
|----------|------|------------|-------------------|--------|
| Fatal | - | - | - | - |
| Serious | - | - | - | - |
| Minor | - | - | - | - |
| None | - | - | 288 | - |
| TOTAL | - | - | 288 | - |

Table 1 Details of Injuries to Persons

1.3. Damage to aircraft

1.3.1. There was no damage to the aircraft.

1.4. Other damages

1.4.1. Not Applicable.

1.5. Personnel information

| Pilot Flying | |
|--------------------------|-----------------------------|
| License type | Air Transport Pilot License |
| Medical date with status | 31-01-2024 |
| Flying experience | 19,245 h |
| On type | 4,679 h |
| Pilot Monitoring | |
| License type | Air Transport Pilot License |
| Medical date with status | 28-02-2024 |
| Flying experience | 7,490 h |
| Type rating | B 777 |

Table 2 Personnel Details

1.6. Aircraft information

| Aircraft Details | |
|-------------------------------|-------------------------|
| Operator | PIAC |
| Call Sign | PK-743 |
| Aircraft Make & Model | Boeing 777-200ER |
| Registration Number | AP-BHM |
| MSN | 32717 |
| Year of manufacturing | December, 2005 |
| Aircraft FH / Aircraft Cycles | 68332 h(s) / 14937 c(s) |
| Engine No.2 | |
| Engine S No | 900127 |
| Manufacturer | GE |
| Engine Type | GE90-94B |
| Date of Installation | 01-Dec-2023 |
| TSN / CSN | 52672 / 13823 |

Table 3 Aircraft / Engine Details

1.6.1. This was the first flight conducted after replacement of right engine. However, there was no prior history of defect associated with this engine.

1.6.2. A disconnection was noted in the HP pneumatic duct connection of the right engine at approximately 3 o'clock position near the High-Pressure Compressor (HPC) case. The clamp of the duct was found in lower section of engine near 6 o'clock position.

1.6.3. The right engine's thrust reverser Pressure Relief 02 doors were found in operated position.

1.6.4. In the cockpit, the right engine fire handle was pulled, and the associated engine fire extinguishing bottle was found discharged.

1.6.5. Maintenance messages 73-31872, 73-32102, and 74-30942 were recorded on Maintenance Analysis and Tracking (MAT) system.

1.7. Meteorological information

1.7.1. METAR: OPKC 020000Z 02004KT 4000 FU NSC 18/08 Q1017 NOSIG

| METAR JIAP, Karachi | |
|---------------------|---|
| OPKC | Station ID - JIAP, Karachi |
| 020000Z | Date and Time - Day 02 & Time 0000 UTC |
| 02004KT | Wind Direction & Speed - 020° & 04 knots |
| 4000 | Visibility - 4,000 m |
| FU | Weather Phenomena - Smoke |
| NSC | No significant clouds |
| 18/08 | Temperature - 18°C / Dew point - 08°C |
| Q1017 | Altimeter setting - Air pressure 1017 hPa |
| NOSIG | No significant change is expected to the reported conditions within the next 2 hours |

Table 4 METAR of JIAP, Karachi

1.8. Aids to navigation

| TYPE OF AID | ID | Frequency | Hours of operation | Site of transmitting antenna coordinates | Elevation of DME transmitting antenna | Remarks |
|---------------------|-----|--------------------|--------------------|--|---------------------------------------|--------------------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| ILS/LOC CAT I 25R | IKC | 110.1 MHz | H24 | 245413.26N 0670835.74E | - | - |
| ILS/LOC CAT I 25L | IQA | 109.7 MHz | H24 | 245359.09N 0670820.43E | - | - |
| NDB | KC | 271.0 kHz | H24 | 245523.80N 0670936.29E | - | Coverage 50NM |
| DVOR/DME (1°E/2020) | KC | 112.1 MHz CH58X | H24 | 245443.06N 0671053.91E | 40.84M | Coverage 200 NM |
| GP/TDME 25R | IKC | 334.4 MHz CH38X | H24 | 245447.28N 0671029.42E | 35.62M | GP 3° RDH 50 FT |
| GP/TDME 25L | IQA | 333.2 MHz CH34X | H24 | 245433.50N 0671017.88E | 30.90M | 3°RDH/TCH 55 FT |

Table 5 Aids to navigation, JIAP, Karachi

1.9. Communications

| Service designation | Call sign | Frequency | Hours of operation | Remarks |
|---------------------|----------------|--------------|--------------------|---------------|
| 1 | 2 | 3 | 4 | 5 |
| APP | Karachi APP | 121.300 MHz | H24 | Secondary |
| APP | Karachi APP | 121.500 MHz | H24 | Emergency |
| APP | Karachi APP | 125.500 MHz | H24 | Primary |
| ATIS | ATIS | 126.700 MHz | H24 | - |
| BS | Radio Pakistan | 830.000 KHZ | HX | 0130-1900 HR |
| BS | Radio Pakistan | 1450.000 KHZ | HX | Variable SKED |
| GCA | Karachi Ground | 118.400 MHz | H24 | Secondary |
| GCA | Karachi Ground | 121.600 MHz | H24 | Primary |
| GCA | Karachi Ground | 121.800 MHz | H24 | Vehicle |
| GCA | Karachi Ground | 123.000 MHz | H24 | - |
| TWR | KARACHI Tower | 118.300 MHz | H24 | Primary |
| TWR | KARACHI Tower | 118.800 MHz | H24 | Secondary |
| TWR | KARACHI Tower | 121.500 MHz | H24 | Emergency |

Table 6 Communication Frequencies of JIAP, Karachi

1.10. Aerodrome information

| Designations RWY NR | True bearing | Dimensions of RWY (M) | Strength (PCN) and surface of RWY and SWY | THR coordinates | THR elevation and highest elevation of TDZ of precision APP RWY | Slope of RWY/SWY |
|-------------------------|-------------------------|---------------------------|--|---------------------------|--|--|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 07L | 74.29° | 3200 x 46 | 54/R/C/X/U Concrete ACFT upto A310 are permitted | 245416.90N 0670851.02E | THR 23.50 M / 77.10 FT | 0.200% UP |
| 25R | 254.29° | 3200 x 46 | 54/R/C/X/U Concrete ACFT upto A310 are permitted | 245444.69N 0671040.84E | THR 30.40 M / 99.74 FT | 0.200% Down |
| 07R | 74.29° | 3400 x 45 | 87/R/BAW/T Concrete SWY bitumen | 245402.15N 0670833.56E | THR 21.62 M / 70.93 FT | 0.168% UP |
| 25L | 254.29° | 3400 x 45 | 87/R/BAW/T Concrete SWY bitumen | 245431.79N 0671030.20E | THR 27.25 M / 89.40 FT | 0.168% Down |
| SWY dimension (M) | CWY dimension (M) | Strip dimension (M) | RESA dimension (M) | Arresting system | Obstacle Free Zone | Remarks |
| 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 100 x 46 | | 3930 x 300 | 180 x 120 | AVBL | | RWY 07L/25R not available for operation from dusk to dawn due to unserviceable approach & associated RWY lights until further advise. Arresting barrier at RWY 07L/25R operated for Military traffic only |
| 100 x 46 | 60 | 3930 x 300 | 75 x 120 | AVBL | - | |
| 305 x 45 | 105 | 4126 x 300 | 180 x 120 | - | - | |
| 301 x 45 | 60 | 4126 x 300 | 150 x 150 | - | - | - |

Table 7 Aerodrome information of JIAP, Karachi

1.11. Flight recorders

1.11.1. Not Applicable.

1.12. Wreckage and impact information

1.12.1. Not Applicable.

1.13. Medical and pathological information

1.13.1. Not Applicable.

1.14. Fire

1.14.1. There was no evidence of fire reported during the investigation.

1.15. Survival aspects

1.15.1. Not Applicable.

1.16. Test & research

1.16.1. Not Applicable.

1.17. Organizational and management information

1.17.1. Not Applicable.

1.18. Additional information

1.18.1. Not Applicable.

1.19. Useful or effective investigation techniques

1.19.1. Standard investigation procedures and techniques were used during the course of investigation.

SECTION 2 – ANALYSIS

2.1. General

2.1.1. On 2nd December 2023, a serious incident occurred involving PIA Flight PK-743, Boeing 777-200ER aircraft bearing registration number AP-BMH, at Jinnah International Airport (JIAP), Karachi. During the climb phase after departure, the flight crew reported an engine fire. Emergency procedures were immediately initiated on board the aircraft. Shortly after, the crew informed ATC that the immediate threat had been mitigated and downgraded the emergency status from “MAYDAY” to “PAN PAN.” The aircraft landed safely back at JIAP, Karachi

2.2. Flight Operations

2.2.1. Flight crew handled the emergency as per Flight Crew Operating Manual (FCOM) instructions.

2.3. Aircraft

2.3.1. Visual inspection of the engine was carried out, however, no evidence of actual fire was observed.

2.3.2. Further inspection of engine revealed a disconnected HP pneumatic duct at 3 o'clock position of the right engine, near the High-Pressure Compressor (HPC) case. The associated duct clamp, which secures the Y-shaped pneumatic duct in the HP bleed air system, was found in the lower engine area near 6 o'clock position.

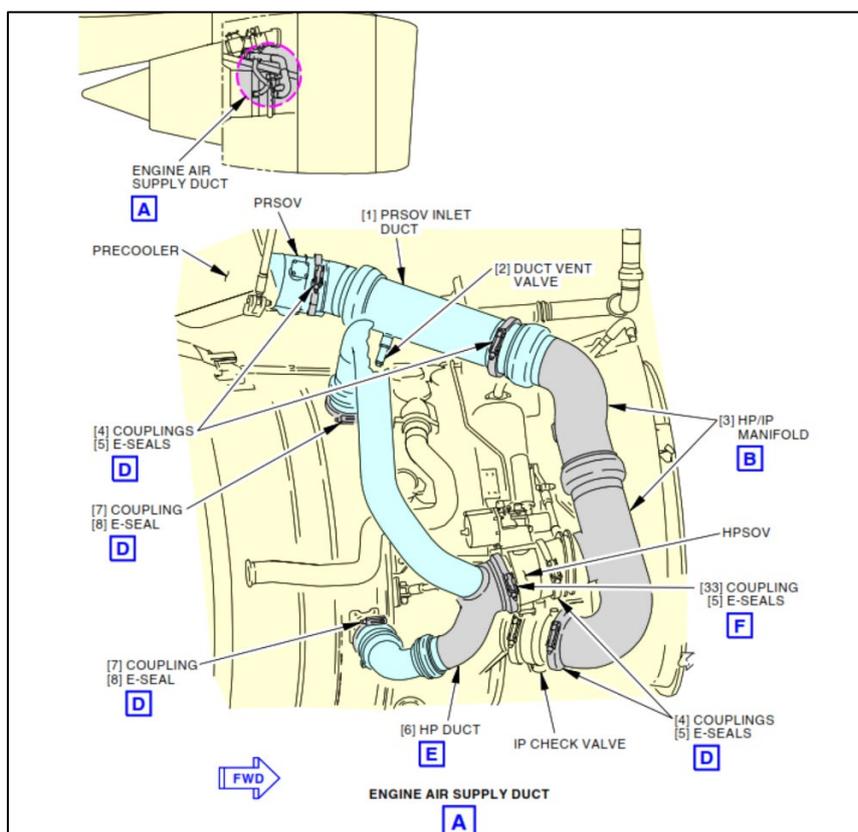


Figure 1 Engine Air Supply Duct

2.3.3. The right engine's thrust reverser Pressure Relief 02 doors were also found in operated position indicating hot air leak in the area. Secondary damage to the righthand thrust reverser cowling also indicate a pneumatic leak in the area.

2.3.4. The collected evidences point towards a right engine overheat warning during flight caused by a significant bleed air leak from the 14th stage of the HPC.

2.3.5. Probable cause for the dislodging of the clamp from the duct can be: -

2.3.5.1. **Material failure or damage to the clamp** – Inspection of the clamp revealed that the clamp was not damaged or deformed, indicating that the disconnection was not caused by material failure of the clamp.



Figure 2 Clamp and Its Locking Mechanism

2.3.5.2. **Material failure or damage to the HP Pneumatic duct** – HP pneumatic duct was found to be serviceable with no indications of being damaged or de-shaped indicating the clamp was not dislodged due to the abnormal HP duct.

2.3.5.3. **Installation error** – As there was no damages or material failure found on the clamp or HP pneumatic duct, therefore, possibility of dislodging can only be due to an error in the installation of the clamp.

2.3.6. The recovered clamp locking mechanism showed absence of visible threads and the locking nut being excessively loose. This condition rendered the clamp ineffective in securing the duct, ultimately allowing it to detach during engine operation.

2.3.7. Detailed inspection of the clamp's locking mechanism was found to be satisfactory as there were no abnormal threads or any hindrance in the locking mechanism and the nut screwed-in properly. This indicates error in the installation of clamp which is discussed in the Human Factor heading.

2.4. Human Factor

2.4.1. Aircraft tech log reveals that aircraft had recently undergone an engine replacement on right-hand side. Cannibalization of Engine was planned to service aircraft AP-BMH for next mission within 48 h of arrival. Engine under discussion was cannibalized from aircraft AP-BMG parked on ground for the past 44 days since its last mission. Clamp may have been disturbed during the cases mentioned below.

2.4.1.1. **Access gained on subject engine when it was on wing of aircraft AP-BMG earlier** – As few pneumatic components i.e.HPFAC controller, High-Pressure Shutoff Valve (HPSOV) valve, Pressure Regulating and Shutoff Valve (PRSOV) inlet duct and fourth was a fuel manifold / casting O-ring were missing once the engine was installed on wing of AP-BMH, therefore, the clamp may have been disturbed during the removal of these components once engine was on AP-BMG and parked for 44 days at the hangar.

2.4.1.2. **Access gained on subject engine when it was on wing of aircraft AP-BMH.** The clamp may have been disturbed once the pneumatic components were being installed on the engine once it was on AP-BMH.

2.4.2. Despite this major maintenance activity, no pneumatic leak checks were performed on right engine (post-installation), and critical components such as the PRSOV and HPSOV were not locked in the “CLOSED” position prior to attempted leak verification, in violation of Aircraft Maintenance Manual (AMM) procedures. This deviation from prescribed procedures represents a non-compliance with standard maintenance protocols. Although the aircraft experienced no structural or thermal damage beyond the engine bleed leak, the failure of the pneumatic system integrity significantly affected engine performance and safety, necessitating discontinuation of operation.

2.4.3. The engine change operation involved multiple teams working across different shifts, including the Wide-Body Hangar (WBH) and Line Maintenance (LM) teams. Furthermore, installation of components like the HPFAC controller and HPSOV valve was carried out under night-shift conditions with limited workspace access. Technicians used ladders instead of appropriate maintenance platforms and had to perform multiple attempts to fit heavy components like the HPSOV. These non-optimal working conditions increased the risk of oversight, fatigue, and procedural deviation.

2.4.4. The team failed to report the difficulty encountered during component installation. This lack of communication prevented escalation of a non-routine maintenance scenario, resulting in missed verification of surrounding components most notably the duct clamp.

2.4.5. Supervision during the post-installation phase seem insufficient as no Aircraft Engineers were assigned to verify the pneumatic leak checks on the outboard (right-hand) engine and the required manual valve positions for leak testing were not verified. These lapses reflect systemic issues in supervision, task allocation, and procedural compliance.

2.4.6. The maintenance documentation and procedural compliance culture appeared to emphasize task completion over thorough verification. The cannibalization of engine and components to meet the operations in short time may have contributed to reduced vigilance and inadequate checks, particularly in the context of high-pressure bleed air system integrity.

2.4.7. The procedural omission of torque verification for clamps not explicitly referenced in the HP bleed valve R&I task illustrates a latent human factor risk the assumption that "non-disturbed" components do not require rechecking, even if they may have been inadvertently accessed or adjusted.

2.4.8. Overall, the incident reflects both active failures e.g. improper torque & skipped leak check and latent conditions (e.g. incomplete supervision, insufficient maintenance resource allocation & inadequate communication). These align with known human factors contributing to maintenance errors in aviation.

SECTION 3 – CONCLUSIONS

3.1. Findings

3.1.1. The aircraft experienced a "RIGHT ENGINE OVERHEAT" message during flight, which necessitated an air turn-back.

3.1.2. Post-flight inspection revealed no evidence of fire or thermal damage in the right engine fan or core sections. The high-pressure (HP) pneumatic duct connection on the right engine, located at 3 o'clock position near the HPC case, was found disconnected.

3.1.3. The associated HP duct clamp/coupling was missing from its designated location and was later found resting in the lower engine area near 6 o'clock position.

3.1.4. Visual inspection of the recovered clamp showed no signs of damage or deformation. However, the clamp appeared to be improperly torqued, as no threads were visible beyond the nut and the nut may have gotten loose due to vibrations, which is contrary to correct torque application standards.

3.1.5. The HP duct clamp was likely loosened unintentionally during the last HP bleed valve removal/installation task to improve access. This was not detected as the R&I procedure does not explicitly require removal or disturbance of the clamp.

3.1.6. Documents reveal that this was the first flight after the engine replacement on the right side of the aircraft.

3.1.7. The engine installed on AP-BMH was a serviceable unit removed from AP-BMG, which was grounded.

3.1.8. The engine change procedure experienced delays due to logistical issues, including the unavailability of a serviceable trolley, but no technical issues were reported. After engine hook-up, fuel, hydraulic, and pneumatic connections were made, and previously cannibalized components were reinstalled. Night-shift conditions with suboptimal tools (ladders instead of platforms), limited accessibility, and poor visibility, increasing the risk of oversight and fatigue-induced errors.

3.1.9. The clamp in question was not checked per AMM procedures and two or more engine motoring cycles were performed inside WBH for hydraulic and fuel leak checks, but no pneumatic leak checks were conducted on the right engine.

3.1.10. The lack of proper torque on the clamp, absence of leak checks, and failure to lock valves as per AMM contributed directly to the in-flight bleed air leak.

3.1.11. Overall, the serious incident reflects both active failures i.e. skipped leak check and latent conditions (e.g. incomplete supervision, insufficient maintenance resource allocation, inadequate communication).

3.2. Cause

3.2.1. The incident was caused by a right engine overheat warning during flight caused by a significant bleed air leak from the 14th stage of the HPC which resulted due to a disconnection of a high-pressure (HP) pneumatic duct on the right engine due to improper installation of its duct clamp.

3.3. **Contributory Factor**

3.3.1. **Improper Installation and Torque Omission** – The clamp securing the HP pneumatic duct was likely loosened during component removal or installation but not re-torqued or verified thereafter. The absence of mechanical deformation on the clamp supports a conclusion of human error during re-installation.

3.3.2. **Non-compliance with Maintenance Procedures** – No leak checks were performed post-engine installation on the right engine, contrary to Aircraft Maintenance Manual (AMM) requirements.

3.3.3. **Human Factors and Work Environment Limitations** – Critical maintenance tasks were performed under night-shift conditions with suboptimal tools (ladders instead of platforms), limited accessibility, and poor visibility, increasing the risk of oversight and fatigue-induced errors.

3.3.4. **Ineffective Communication and Task Handover** – Technicians did not report unusual installation difficulties (e.g., multiple HPSOV fitting attempts, unorthodox E-seal alignment), preventing escalation or cross-checks during successive shift turnovers.

3.3.5. **Organizational Culture and Documentation Gaps** – A task-oriented maintenance culture, influenced by logistical pressure and reliance on cannibalized parts is evident. Further, lack of communication between maintenance teams of the components disturbed during the completion of task at hand led to missing of verification processes for those components that required re-inspection.

Note: Aviation Occurrence Category (ADREP Taxonomy)

FIRE/SMOKE (NON-IMPACT) (F-NI)

Fire or smoke in or on the aircraft, in flight, or on the ground, which is not the result of impact.

SECTION 4 – SAFETY RECOMMENDATIONS

4.1. Safety Recommendations

PIA

4.1.1. Maintenance Procedure Compliance:

4.1.1.1. It is recommended that maintenance task cards be revised to explicitly include verification of adjacent or potentially affected components even if not directly referenced in the R&I (Removal and Installation) procedure to mitigate oversight of disturbed items such as clamps and ducting.

4.1.2. Post-Maintenance Verification & Sign-Off: -

4.1.2.1. The airline should establish and enforce a dual-verification system for all critical engine and pneumatic system connections, such as duct clamps and valves, during and after engine installation. This should include a documented torque check where applicable.

4.1.3. Supervision and Quality Assurance: -

4.1.3.1. Maintenance Control should enhance oversight and quality assurance during engine changes, especially in night-shift operations, by assigning a dedicated certifying engineer to each engine side with the authority and responsibility to verify task execution and compliance with procedures.

4.1.3.2. A supervisory checklist should be developed for post-installation validation of high-risk systems (e.g. pneumatic, hydraulic, fuel), ensuring that all manual valve positions, connector torque values, and component security are properly reviewed before return-to-service.

4.1.4. Human Factors and Maintenance Environment: -

4.1.4.1. The airline should conduct a formal Human Factors Risk Assessment (HFRA) for night-shift maintenance operations involving heavy components and limited-access areas.

4.1.4.2. Training programs should be revised to incorporate non-technical skills (NTS) such as communication, reporting difficulties, escalation of anomalies, and proper handover practices between shifts, emphasizing the importance of reporting abnormal installation challenge.

4.1.5. Component Cannibalization and Configuration Control: -

4.1.5.1. The use of cannibalized components should be accompanied by strict configuration control measures, including inspection history verification, installation environment suitability, and torque re-certification requirements, especially for safety critical parts.

4.1.6. Documentation and Procedural Culture: -

4.1.6.1. The operator should conduct an internal audit of its maintenance documentation culture, with particular focus on identifying systemic gaps that prioritize task closure over procedural accuracy and completeness.

4.1.6.2. Maintenance documentation should be updated to require written acknowledgement and sign-off whenever components are accessed or adjusted for clearance, even if they are not the primary subject of a maintenance task.