FINAL INVESTIGATION REPORT

SERIOUS INCIDENT (TCAS – RA) – KUWAIT AIRWAYS FLIGHT KAC920, BOEING 777-369(ER) AIRCRAFT, REG. NO. 9K-AOE (SECTOR GUANGZHOU TO KUWAIT) AND MILITARY AIRCRAFT ON 01-12-2021

SCOPE

At Bureau of Aircraft Safety Investigation (BASI), Pakistan investigations are conducted in accordance with Annex-13 to the International Civil Aviation Organization (ICAO) Convention on International Civil Aviation and Civil Aviation Rules 1994 (CARs 94).

The sole objective of the investigation and the final report of an accident or serious incident under above stated regulations is the prevention of future accidents and incidents of similar nature. It is not the purpose of such an investigation to apportion blame or liability. Accordingly, it is inappropriate to use BASI Pakistan investigation reports to assign fault or blame or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.

This report contains facts, which have been determined up to the time of publication. Such information is published to inform the aviation industry and the public about the general circumstances of civil aviation accidents and incidents.

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ABBREVIATIONS

AAIB	Aircraft Accident Investigation Board
BASI	Bureau of Aircraft Safety Investigation
AGL	Above Ground Level
AHQ	Air Headquarters
ATC	Air Traffic Control
ATS	Air Traffic Services
CARs	Civil Aviation Rules
FL	Flight Level
ft	Feet
h	Hour(s)
hPa	Hectopascal
IIAP	Islamabad International Airport
ICAO	International Civil Aviation Organization
IOU	Incident Occurrence and Unserviceability Report
Kg	Kilogram(s)
kts	Knots
MAC	Mid Air Collision
MET	Metrological
min	Minute(s)
MWO	Meteorological Watch Office
NM	Nautical Miles
NTSB	National Transportation Safety Bureau
PAF	Pakistan Air Force
PCAA	Pakistan Civil Aviation Authority
RA	Resolution Advisory
ROC	Rate of Climb
R/W	Runway
SOC	Sector Operational Command
TA	Traffic Advisory
TCAS	Traffic alert and Collision Avoidance System
UTC	Universal Time Coordinated

INTRODUCTION

The serious incident was reported to Bureau of Aircraft Safety Investigation (BASI), Pakistan previously known as Aircraft Accident Investigation Board (AAIB) by Pakistan Civil Aviation Authority (PCAA) vide Incident Occurrence and Unserviceability Report (IOU)[1]. Ministry of Aviation, Government of Pakistan issued Memorandum[2] and Corrigendum[3] issued by BASI, Pakistan to investigate the serious incident. This serious incident was notified[4] to International Civil Aviation Organization (ICAO) and National Transportation Safety Bureau (NTSB), United States of America (USA) in line with Annex-13. The investigation has been conducted by BASI, Pakistan. All corresponding timings are mentioned in Universal Time Coordinated (UTC).

[1] PCAA IOU Report dated 1st December, 2021
[2] Ministry of Aviation Memorandum No. HQCAA/1902/001/TCAS/Inv dated 25th March, 2022
[3] BASI Pakistan Corrigendum
[4] Initial Notification to ICAO and NTSB dated 6th December, 2021

SYNOPSIS

On 1st December, 2021, Kuwait Airways Flight KAC920, Boeing 777-369(ER) aircraft, Reg. No. 9K-AOE was operating from Guangzhou Baiyun International Airport (ZGGG), China to Kuwait International Airport (OKBK), Kuwait on Air Traffic Services (ATS) route G452 maintaining Flight Level (FL) 340.

At time 0652 hours (h), when KAC920 was approximately 45 Nautical Miles (NM) East of position Rahim Yar Khan (RK), it reported Traffic alert and Collision Avoidance System (TCAS) – Resolution Advisory (RA) and initiated RA climb from FL340 to FL348.

02 x F-16 Military aircraft from PAF Base Shahbaz, Jacobabad were operating East of 'RK' at coordinated levels between FL260 and FL200. One of the Military aircraft squawking A4372 was observed 3 NM North of 'RK' at FL245 in climbing phase and subsequently disappeared from the radar display.

After some time, same Military aircraft squawking A4372 reappeared on radar display at position 18 NM East of 'RK' and 20 NM reciprocal to KAC920 climbing out of FL262 with high Rate of Climb (ROC), approximately 6,000 feet (ft) / minute (min). The military aircraft crossed KAC920 at 9 o'clock, approximately 2 NM at FL334, which resulted in activation of TCAS – RA of KAC920.

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SECTION 1 - FACTUAL INFORMATION

1.1. History of the Flight

1.1.1. On December 1st, 2021, Kuwait Airways Flight KAC920, a Boeing 777-369(ER) with registration number 9K-AOE, was conducting a scheduled commercial passenger flight from ZGGG, (Guangzhou, China) to OKBK (Kuwait International Airport, Kuwait) on ATS route G452 and maintaining FL340.

1.1.2. 02 x F-16 Military aircraft from PAF Base Shahbaz, Jacobabad were operating east of RK at coordinated levels, initially between FL240 and FL200, later between FL260 and FL200.

1.1.3. One of the Military aircraft squawking A4372 was observed 3 NM North of RK at FL245 in a climbing phase before disappearing from the radar display. PAF Base Shahbaz, Jacobabad and Sector Operational Command (SOC) South were immediately contacted to confirm the aircraft's flight level. Upon query, SOC South responded that they were unable to disclose this information due to the nature of the exercise.

1.1.4. After some time, the same military aircraft, squawking A4372, reappeared on radar at position 18 NM east of RK and 20 NM in the reciprocal direction to KAC920. It was climbing out of FL262 with a high ROC (approximately 6,000 ft / min).

1.1.5. At time 0651 h, when KAC920 was approximately 45 NM east of position RK, it reported a TCAS – RA.

1.1.6. KAC920 initiated RA climb from FL340 to FL348. The military aircraft crossed KAC920 at its 9 o'clock position, approximately 2 NM away at FL334.

1.1.7. KAC920 was taken on vectors upon observing the manoeuvres of the military aircraft, while providing relevant traffic information.

1.2. Injuries to Person(s)

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

1.3. Damage to Aircraft

1.3.1. No damage was reported due to this incident to any of the aircraft.

1.4. Other Damage

1.4.1. Not Applicable.

1.5. Personnel Information

1.5.1. Not Applicable.

1.6. **Aircraft Information**

KAC920	
Aircraft Make & Model	Boeing 777-369ER
Registration Marking	9K-AOE
Manufacturer Serial No.	62563
Year of Manufacturer	2016
Operator	Kuwait Airways
Sector	Guangzhou to Kuwait
Flight Level	FL340

Table 1 Aircraft details

1.7. **Meteorological Information**

1.7.1. No significant weather was reported by Meteorological Watch Office (MWO) for Lahore Flight Information Region (FIR) at the time of the incident.

1.8. **Aids to Navigation**

1.8.1. Not Applicable.

1.9. **Communications**

1.9.1. Communication frequencies for Lahore FIR are provided below. At the time of incident, no abnormality was reported.

Name Lateral limits Vertical limits Class of airspace	**Unit providing service**	**Callsign/ Language Area and conditions of use Hours of service**	**Frequency/ purpose**	**Remarks**
1	2	3	4	5
LAHORE CTA *Area bounded by lines joining points 310000N/0735958E; 300501N/0724558E; 302001N/ 0722758E; 312600N/0725058E; 315000N/0734958E; 324900N/0730758E; 325800N/0733758E; 320700N/ 0741957E then along the counter clockwise arc of a circle of 34.5NM radius centred on 312959N/ 0742400E to 310000N/0740000E to point of origin.* *UNL* *FL075* Class of airspace: A - At and above FL155 C – Below FL155	Lahore ACC (EAST)	Lahore Control (English) H24	121.5 MHZ Emergency FREQ 127.5 MHZ Primary FREQ 132.55 MHZ Secondary FREQ	RCAG 124.1 MHZ will serve as secondary frequency. RCAG 127.5 MHZ will serve as secondary frequency.
	Lahore ACC (WEST)	Lahore Control (English) H24	118.95 MHZ Secondary FREQ 121.5 MHZ Emergency FREQ 124.1 MHZ Primary FREQ	
	Lahore South	Lahore South (English) H24	121.5 MHZ 123.15 MHZ 132.95 MHZ	

Table 2 Communication Frequencies, Lahore FIR

1.10. **Aerodrome Information**

1.10.1. Not Applicable.

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. Not Applicable.

1.15. **Survival Aspects**

1.15.1. Not Applicable.

1.16. **Test and Research**

1.16.1. Not Applicable.

1.17. **Organizational and Management Information**

1.17.1. Not Applicable.

1.18. **Additional Information**

1.18.1. **TCAS Working Principle –** TCAS stands for Traffic alert and Collision Avoidance System, and its purpose is to minimize the risk of mid-air collisions between aircraft. Working independently from Air Traffic Control, TCAS uses nearby aircraft's transponder signals to alert pilots to the danger of mid-air collisions. It does so by constructing a three-dimensional map of airspace through which the aircraft is travelling. In detecting the other aircraft's transponder signals, it can foresee the potential collisions based on speeds and altitude of planes passing through the airspace in question. If TCAS detects a potential collision, it will automatically notify each of the affected aircraft. In this instance, it will automatically initiate a mutual avoidance manoeuvre. This involves the system informing the crews of the aircraft in question both audibly and visibly to either climb or descend in a manner that ensures that, when their paths cross, they do not meet.

Figure 1 TCAS (TA) alert

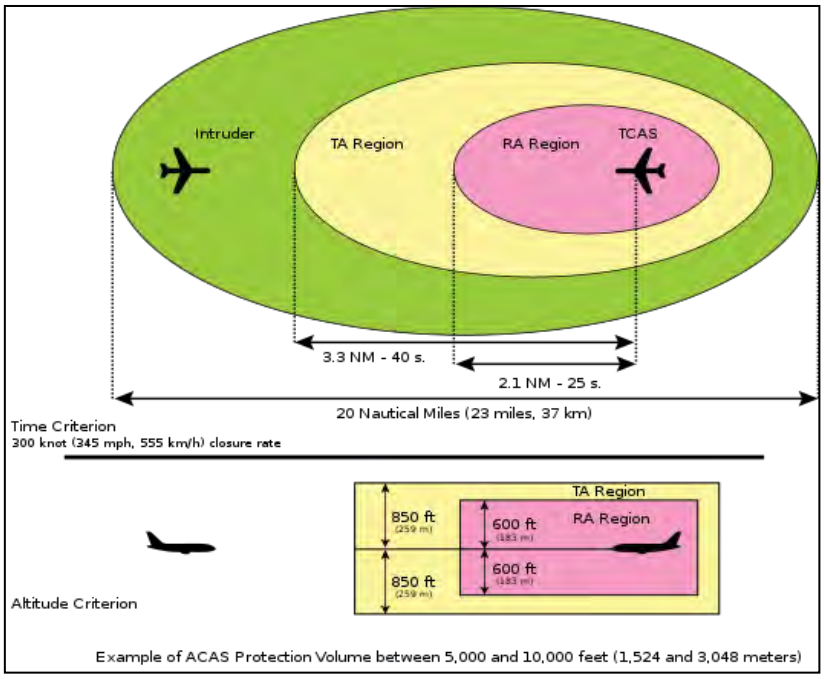

Figure 2 TCAS TA & RA ranges

1.18.2. **Airborne Collision Avoidance System (ACAS)**

1.18.2.1. The objective of ACAS is to provide advice to pilots for the purpose of avoiding potential collisions. This is achieved through Resolution Advisories (RAs), which recommend actions (including manoeuvres), and through Traffic Advisories (TAs), which are intended to prompt visual acquisition and to act as a precursor to RAs.

1.18.2.2. ACAS equipment in the aircraft interrogates Mode ‘A’ / ’C’ and Mode ‘S’ transponders on aircraft in its vicinity and listens for their replies. By processing these replies, ACAS determines which aircraft represent potential collision threats and provides appropriate display indications (or advisories) to the flight crew to avoid collisions.

1.18.2.3. **Traffic Advisories (TAs) -** TAs alert the flight crew to potential RAs and may indicate the range, range rate, altitude, altitude rate and bearing of the intruding aircraft relative to own aircraft. TAs without altitude information may also be provided on Mode ‘C’ or Mode ‘S’ equipped aircraft that have temporarily lost their automatic altitude-reporting capability. The information conveyed in TAs is intended to assist the flight crew in sighting nearby traffic.

1.18.2.4. **Resolution Advisories (RAs) -** If the threat detection logic in the ACAS computer determines that an encounter with a nearby aircraft could soon lead to a near-collision or collision, the computer threat resolution logic determines an appropriate vertical manoeuvre that will ensure the safe vertical separation of the two aircraft. The selected manoeuvres ensure adequate vertical separation within constraints imposed by the climb rate capability and proximity to the ground of the two aircraft.

1.18.2.5. The RAs provided to pilot can be divided into two categories: corrective advisories, which instruct pilot to deviate from the current flight path ("CLIMB" when aircraft is in level flight); and preventive advisories, which advise the pilot to maintain or avoid certain vertical speeds ("DON'T CLIMB" when aircraft is in level flight).

1.18.2.6. **Warning Times -** In any potential collision, ACAS generates an RA nominally 15 to 35 seconds (s) before the Closest Point of Approach (CPA) of the aircraft. The ACAS equipment may generate a TA up to 20 s in advance of an RA. Warning times depend on Sensitivity Levels (SLs) of RAs.

1.18.3. **Traffic Display Symbology –** On the TCAS traffic display both colour and shape are used to assist the pilot in interpreting the displayed information.

1.18.3.1. Own-aircraft is depicted as a white or yellow aircraft-like symbol. Targets are displayed by different symbols, according to their threat status

1.18.3.2. Hollow white diamond – for other traffic. (No threat).

1.18.3.3. Solid white diamond – for proximate traffic.

Figure 3 Traffic Display

1.18.3.4. Solid yellow or amber circle – for intruders (i.e. aircraft which trigger a TA).

1.18.3.5. Solid red square – for threats (i.e. aircraft which trigger an RA).

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 1st December, 2021 a transit flight of Kuwait Airways KAC290, Boeing 777-368(ER) aircraft, Reg. No. 9K-AOE was operating from ZGGG, China to OKBK, Kuwait following ATS route G452 maintaining FL340.

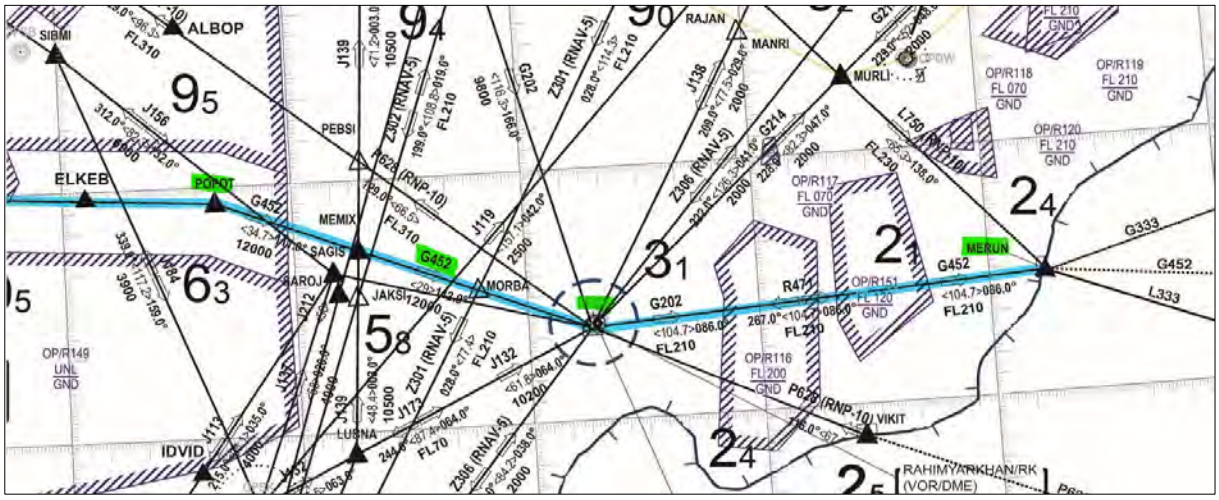

Figure 4 KAC920 Flight Plan Route

2.1.2. At 06:29:26 h, Shahbaz ATC Tower, Jacobabad coordinated with Area Control Centre (ACC) Lahore South regarding a formation of military aircraft (02 x F-16) planned to operate at FL200 and a heading 090°. Initially, only a single F-16 aircraft was expected to operate, which would later be joined by a second aircraft.

2.1.3. At 06:38:16 h, Shahbaz, ATC Tower, Jacobabad confirmed squawk A4371 and A4372 for the military formation and informed that they would operate between FL240 and FL200. Upon further confirmation by ACC South, Shabaz ATC later updated that the fighters will now operate between FL260 and FL200[5].

2.1.4. At 06:40:45 h, KAC920 came in contact with ACC Lahore South, maintaining FL340 at position MERUN. After identification, KAC920 was cleared according to the flight plan route by ACC Lahore South.

2.1.5. At this time, a formation of 02 x F-16 PAF Military aircraft were operating east of 'RK' at coordinated levels between FL260 and FL200.

2.1.6. At time 06:47:33 h, one of the military aircraft, squawking A4372, was observed 3 NM north of 'RK' at FL246 in a climbing phase and subsequently disappeared from the radar.

[5] Statement of Area Radar Controller

Figure 5 Military aircraft observed approx 03 NM North of RK

2.1.7. At time 06:49:28 h, military aircraft squawking A4372 reappeared on radar display, climbing out of FL262 at a position 18 NM east of 'RK' and 20 NM on a reciprocal heading to KAC920.

2.1.8. ACC Lahore South immediately contacted Shahbaz ATC Tower, Jacobabad and SOC South to verify the flight level of the military aircraft. In response, SOC South stated that they were unable to disclose exact information due to the nature of the exercise.

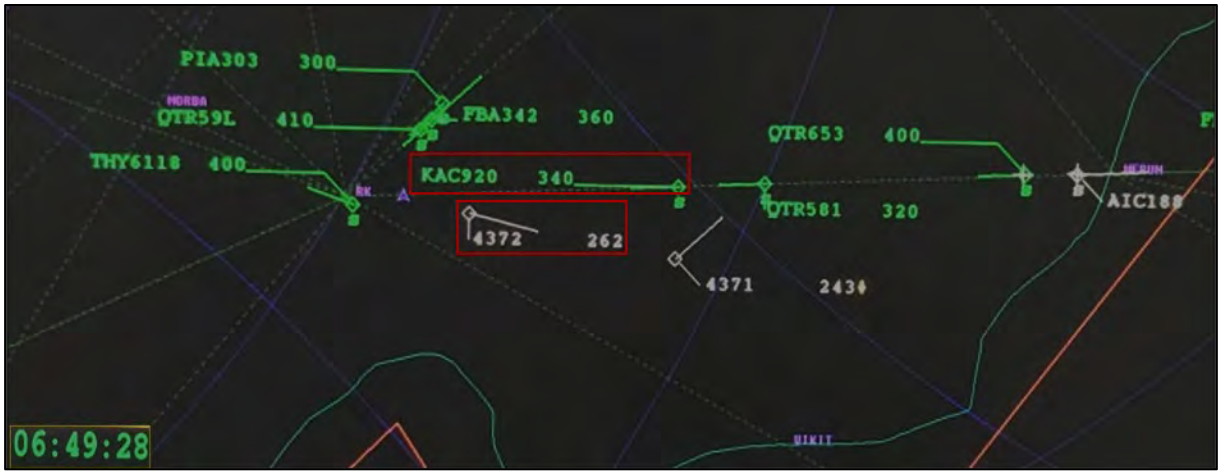

Figure 6 Military aircraft climbing FL262

2.1.9. At this time, the military aircraft was maintaining high ROC of approximately 6,000 ft / min as per controller's statement[6].

2.1.10. At 06:50:13 h, ACC Lahore South cleared KAC920 direct to position POPOT in order to avoid a possible conflict. Although KAC920 acknowledged the instruction, it did not alter its heading.

2.1.11. At 06:51:03 h, ACC Lahore South again instructed KAC920 to proceed directly to POPOT and provided traffic information regarding an uncontrolled aircraft at its 9 o'clock position, range 02 NM away at FL334.

[6] Statement of Area Radar Controller

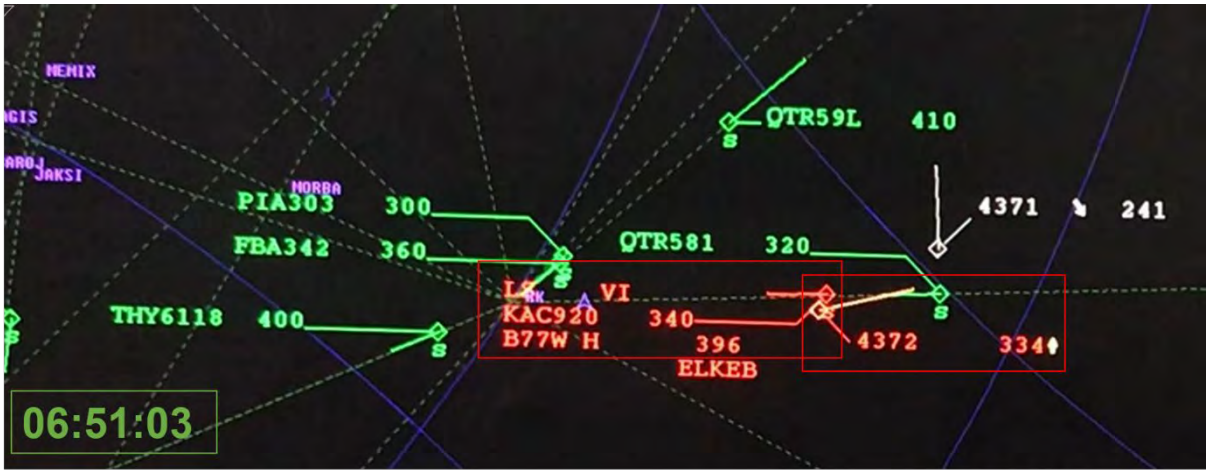

Figure 7 Military aircraft climbed FL334

2.1.12. At 06:51:05 h, KAC920 reported TCAS – RA and initiated a climb to FL348 in response to the RA activation (Figure 7).

Figure 8 TCAS-RA activation

2.1.13. The military aircraft crossed KAC920 at its 9 o'clock position, approximately 02 NM away at FL334, which triggered the activation of TCAS – RA.

2.1.14. At 06:51:36 h, KAC920 reported it was clear of traffic and descended back to FL340 from FL348 while the military aircraft was descending through FL312 (Figure 8). The other fighter aircraft remained within the coordinated block between FL260 and FL200 throughout the event.

Figure 9 KAC920 reporting clear of conflict

2.1.15. At 07:01:02 h, upon inquiry by ACC Lahore South, KAC920 informed that it had received RA followed by RA climb. KAC920 further informed that the traffic had been climbing with high ROC slightly to their left about 500 ft below them.

2.1.16. KAC920 continued its flight to the destination according to its flight plan without any further incident.

2.1.17. Vertical Separation of approximately 600 ft and lateral separation of 02 NM existed between military aircraft and KAC920 at the time of RA.

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SECTION 3 – FINDINGS

3.1. Findings

3.1.1. Flight KAC920 operated from ZGGG, China to OKBK, Kuwait via ATS route G452. No SIGMET (Significant Meteorological Information) was issued on 01-12-21 by Meteorological Watch Office (MWO) in Lahore for Lahore Flight Information Region.

3.1.2. KAC920 at FL340 was identified and cleared as per flight plan by ACC Lahore south.

3.1.3. 02 x F-16 military aircraft from PAF Base Shahbaz, Jacobabad, were operating east of 'RK' at coordinated levels between FL260 and FL200. One of the Military aircraft, squawking A4372, was observed 03 NM north of 'RK' at FL245 in climbing phase before disappearing from the radar.

3.1.4. ACC Lahore South promptly contacted Shahbaz ATC Tower and SOC South to confirm the assigned flight level of the military aircraft. In response to the query, SOC South declined to disclose specific details about the exercise due to its classified nature.

3.1.5. Military aircraft squawking A4372 reappeared on radar, climbing out of FL264, at position 18 NM east of 'RK' and 20 NM on a reciprocal path to KAC920, with a high ROC (approximately 6,000 ft / min, as stated by Area Radar Controller).

3.1.6. Upon observing the manoeuvres of military aircraft on a reciprocal course to KAC920, ACC Lahore South cleared KAC920 directly to position POPOT, with traffic information regarding uncontrolled aircraft as being 9 o'clock range 02 NM at FL334. However, KAC920 reported TCAS – RA and initiated climb up to FL348 as a result of RA activation. KAC920 further reported that the conflicting traffic was climbing with high ROC approximately 500 ft below and slightly to the left.

3.1.7. After crossing the reciprocal military traffic, KAC920 reported clear of conflicting traffic and descended back to FL340.

3.1.8. Subsequently, the PAF formation continued with its mission profile and KAC920 resumed its flight as per flight plan without any further incidents.

3.1.9. Approximately 600 ft vertical and 02NM lateral separation existed between military aircraft and KAC920 at the time of RA.

3.2. Cause / Contributory Factors

3.2.1. Cause

3.2.2. Activation of TCAS – RA **(MAC – Mid Air Collision)** due to an abrupt change in the altitude of a military aircraft.

3.2.3. Contributory Factors

3.2.3.1. There was a **lack of coordination** and information sharing between military ATC and SOC South with civil ATC Controller.

3.2.3.2. SOC **allotted levels** above the coordinated height band (FL260 - FL200) to fighters, **without intimation and coordination** with ACC Lahore Controller.

3.2.3.3. Neither PAF Base Shahbaz Controller nor civil Controller took timely action by giving call on emergency frequency to fighters, which might have avoided the incident.

Note: Aviation Occurrence Category (ADREP Taxonomy)
*"**Mid-Air Collision (MAC):** Separation-related occurrences caused by either air traffic control or cockpit crew*

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SECTION 4 – SAFETY RECOMMENDATIONS

4.1. **Safety Recommendations**

4.1.1. Aircraft separation must be maintained in accordance with SOPs. Air Headquarters (AHQ) and Pakistan Airports Authority (PAA) should issue directives to all controlling units to ensure compliance with these SOPs.

4.1.2. AHQ and PAA should conduct regular training sessions / lectures for all controllers regarding adherence to SOPs.

4.1.3. A proactive approach should be adopted by all controllers to ensure swift and smooth coordination and prevent reoccurrences of such incidents in future.