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Analysis of the Malfunction and Handling of the Navtech Radar in an Airport Perimeter Security System

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Abstract

The Navtech AdvanceGuard radar is a core component of the Perimeter Intruder Detection System (PIDS) that monitors and detects object movement along the perimeter area of Juanda International Airport, Surabaya, integrated with Pan/Tilt/Zoom (PTZ) cameras for automatic visual tracking. During the study period, Aviation Security (AVSEC) officers reported that the Navtech radar was not functioning. This article aims to analyze the cause of the malfunction and document the repair process. The method used was field observation and systematic troubleshooting, consisting of checking the radar status through the monitoring application, measuring the power supply, and testing the camera cabling network. The initial inspection showed the radar status as red (off) due to a malfunctioning power supply, which also caused the network indicator on the switch to go dark; replacing the power supply restored the radar to normal (running) status. However, further verification found that the PTZ camera could not follow the radar's commands due to corrosion on the RJ45 connector of the camera cable. The repair was carried out by replacing the RJ45 connector and re-crimping it, and the test results showed the network indicator functioning normally again, with the radar able to be monitored and to control the camera as intended. This case study emphasizes the importance of preventive maintenance of power supplies and network connectors on outdoor electronic equipment to maintain the reliability of an airport's perimeter security system. The findings are limited to a single case.

Keywords: Navtech radar, PIDS, troubleshooting, RJ45 connector, perimeter security

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Introduction

Aviation safety and security (AVSEC) is a primary aspect that every airport operator is required to uphold, as regulated under the provisions of the International Civil Aviation Organization (ICAO), which have been adopted into the national aviation system (Candra Susanto & Keke, 2019). In addition to passenger and baggage screening, these provisions also require securing the airport's perimeter area -- the physical boundary separating the flight operational area (airside) from the public area (landside) -- in order to prevent unauthorized intrusion into the airside.

The Perimeter Intruder Detection System (PIDS) is one technology solution widely applied at international airports to automatically secure the perimeter area. Sensor-network-based systems have been designed to accurately detect intrusions in an airport's flying area, capable of identifying the type of intrusion, determining the target's location, and suppressing false alarms caused by environmental disturbances (Liu & Lu, 2015). One commonly used type of PIDS is a ground-surveillance radar-based system integrated with a Pan/Tilt/Zoom (PTZ) camera, in which the radar detects and tracks object movement along the perimeter path, while the camera is automatically directed to the point of intrusion for visual verification. Alongside radar, other perimeter detection approaches have been developed, including laser-based detection for airport perimeters (Wu et al., 2017), distributed fiber-optic sensing (Mahmoud et al., 2012), and video-based analytics (Lohani et al., 2022); in each case, the detection layer is only as dependable as the power and network infrastructure behind it.

In principle, perimeter security radars generally operate based on continuous wave (CW) or frequency modulated continuous wave (FMCW) technology, which continuously emits radio waves and analyzes the Doppler frequency shift of the reflected signal to determine the speed and position of a moving object (Salem & Hosseny, 2024). This technology was chosen for its ability to perform real-time target detection with relatively low power consumption and an accuracy level adequate for wide-area surveillance applications such as an airport perimeter. The data produced by the radar is then processed by a central server and displayed in a monitoring application, allowing officers to directly monitor the status of each radar segment as well as the movement track of detected objects.

As electronic equipment installed and operated continuously outdoors, PIDS supporting components such as the power supply and network connectors are prone to performance degradation from exposure to environmental conditions. Studies on electrical connector reliability show that outdoor conditions -- including humidity, vibration, and temperature changes -- can accelerate oxidation and corrosion on connector contact surfaces, ultimately increasing contact resistance and causing functional failure (Song et al., 2024;

Zhang et al., 2025). The power supply component is also a critical element prone to failure in security electronic systems; a Markov-based reliability analysis of a control device's power supply system shows that components such as the rectifier, inverter, and battery contribute significantly to the risk of overall system function failure if not monitored periodically (Ciszewski et al., 2025). Technician competency in diagnosing this kind of fault is also shaped through direct involvement in handling problems in the field, which has been shown to contribute to the work readiness of aviation vocational technicians (Lubis, 2021) and to the alignment of technical understanding with industry work systems (Darni et al., 2025).

During the study period, the Airport Technology Unit of Juanda International Airport, Surabaya, received a report from AVSEC officers that the Navtech radar in the PIDS was not functioning. The literature reviewed above covers PIDS design, radar principles, and the reliability of connectors and power supplies in general, but it does not describe the field diagnosis of combined power-supply and network-connector faults in an airport radar-camera PIDS; this study addresses that gap through a documented single case. This article aims to (1) systematically analyze the cause of the malfunction, (2) document the handling steps and repair verification carried out, and (3) relate the field findings to the literature on the reliability of perimeter security radars and their supporting components, so that this study may serve as a reference for troubleshooting practice and the maintenance of similar PIDS equipment in the future.

Research Method

This study uses a descriptive qualitative method with a case study approach, as put forward by Baxter and Jack (2008), which systematically describes the process of identifying the cause and handling the malfunction of a single radar unit that is part of a PIDS system, as is commonly used in applied, field-practice-based research in the aviation security field (Ulfa, 2022). This approach was chosen because the problem under study is specific to a single event (single case) and requires a narrative-technical tracing of the root cause, rather than hypothesis testing on a large sample. A similar approach has been used in research evaluating airport security technology (Hofer & Wetter, 2012), showing that a descriptive case study is effective for revealing the cause and handling process of a problem in depth for a single unit of study. Data collection techniques were carried out in three ways: direct observation at the incident site, technical measurement using the radar monitoring application and electronic

instruments, and documentation of each stage of the tracing and repair process in the form of photographs and field notes.

Data were collected directly at the incident site, at the Airport Technology Unit, Juanda International Airport, Surabaya, airport operator name withheld for double-blind review, during the period of 2 January-28 February 2025. The object of this study is one Navtech radar unit, model HDR281, that is part of the Perimeter Intruder Detection System (PIDS), based on an AVSEC officer's report that the radar was not functioning.

The tools used in the troubleshooting process included: the Navtech AdvanceGuard monitoring application together with a laptop, to check the radar status remotely via the Navtech web interface; an electronic measuring instrument to check the voltage of the radar and camera power supplies; a replacement RJ45 connector together with a crimping tool, to reattach the connector on the camera network cable; and LED indicators on the network switch, to verify the continuity of the data path. The monitoring application was selected as the initial diagnostic instrument for its ability to display the status of each radar unit in real time without needing to visit the site first, thereby speeding up initial identification before physical tracing was carried out.

The troubleshooting stages carried out were as follows: (1) receiving a report from AVSEC officers that the Navtech radar was not functioning; (2) checking the radar status through the monitoring application and finding a red (off) status; (3) visiting the site to check the power source and the radar's power supply, and finding that the power supply was not functioning, with the status indicator on the switch also dark; (4) replacing the power supply with a new one and verifying via the application that the radar status had returned to normal (running); (5) confirming with AVSEC, but receiving a follow-up report that the PTZ camera could not follow the radar's commands; (6) checking the camera's power supply and confirming the voltage was at a normal 24 volts; (7) checking the RJ45 connector on the camera cable path and finding indications of corrosion; (8) replacing the RJ45 connector and reattaching it to the switch using a crimping tool; and (9) conducting a retest, which showed the switch indicator lit normally and the radar able to be monitored and to control the camera as intended.

Results and Discussion

Object Profile and Scope of the Study

The object of this study is one Navtech radar unit, model HDR281, installed along the perimeter fence of Juanda International Airport, Surabaya, as part of the Perimeter Intruder Detection System (PIDS) under the management of the Airport Technology Unit of the airport operator. This radar is integrated with a Pan/Tilt/Zoom (PTZ) camera that automatically directs toward the point of any

detected object movement, allowing AVSEC officers to perform direct visual verification of potential intrusions into the airport's airside area.

Working Principle of the Navtech Radar and the Perimeter Intruder Detection System (PIDS)

The Navtech AdvanceGuard system works by continuously monitoring the output of one or more radar sensors installed along the perimeter path. The received data is processed by a central server (Piccadilly), which translates the radar signal into movement-track information for each detected object, complete with estimated size, direction, and position precision. The system then decides when an alarm should sound based on a programmed set of rules, while simultaneously controlling the PTZ camera to automatically point toward the intrusion location. This kind of network-sensor-based approach has been shown to accurately identify the type of intrusion and determine the target's location in PIDS applications in airport flying areas (Liu & Lu, 2015). Technically, perimeter security radars of this type generally use continuous-wave (CW) or frequency-modulated continuous-wave (FMCW) principles to determine the range, speed, and position of moving objects in real time (Kim et al., 2019; Salem & Hosseny, 2024); the exact modulation and scanning method of the Navtech unit studied here should be confirmed against the manufacturer's documentation. The development of short-range FMCW radar capable of suppressing clutter interference from vegetation such as trees and shrubs is also a direction of perimeter radar technology development aimed at improving the accuracy of moving-object detection in complex outdoor environments (Yanegh & Baladi, 2025).

Problem Identification

Based on a report from Aviation Security (AVSEC) officers, the Navtech radar in the PIDS was not functioning. This condition had the potential to create a gap in the surveillance of the airport's perimeter area, given that the radar is the core component that detects object movement before visual verification by the PTZ camera, so a malfunction in the radar could reduce the overall effectiveness of the intrusion-detection system.

Diagnosis and Malfunction Analysis

Diagnosis was carried out in stages in accordance with the method described above. Technicians from the Airport Technology Unit, together with the authors, checked the radar status through the monitoring application and found a red status, indicating the radar was off. The check continued on-site to inspect the power source and the radar's power supply, and it was found that the

power supply was not functioning, with the status indicator on the network switch also dark. After the power supply was replaced and the radar status returned to normal (running), the technicians contacted AVSEC for confirmation but received a follow-up report that the PTZ camera could not follow the radar's commands. Further checking of the camera's power supply showed the voltage at a normal 24 volts, so the tracing was directed toward the camera's network cable path.

A summary of the inspection stages is presented in Table 1.

Table 1. Navtech Radar PIDS Inspection Stages and Results

No.	Inspection Stage	Result	Remarks
1	Radar status in monitoring application	Red (off)	Faulty
2	Check of radar power supply	Not functioning, switch indicator dark	Damaged
3	Check after power supply replacement	Radar status: running (normal)	Normal
4	Confirmation of PTZ camera following radar	Camera not responding to radar commands	Faulty
5	Check of camera power supply	24 volts, normal	Good
6	Inspection of camera cable RJ45 connector	Connector shows corrosion	Damaged
7	Test after RJ45 replacement	Switch indicator lit green, radar can be monitored	Normal

Table 1 shows that the PIDS malfunction actually originated from two distinct fault points -- the non-functioning radar power supply at the initial stage, and the corroded camera RJ45 connector at the subsequent stage -- so the repair needed to be carried out in stages for each of these components. Whether the two faults are related (for example, whether the power-supply failure affected the data path) was not examined.

Figure 1 presents a flowchart that summarizes the entire diagnosis and handling process, from checking the radar status through the monitoring application, replacing the power supply, verifying the radar status's return to normal, through to checking and replacing the camera's RJ45 connector, up to the final test.

Further inspection of the camera cable's RJ45 connector found indications of corrosion on the connector's contact surface. This corrosion probably increased the contact resistance (which was not measured in this study), preventing the network signal from being transmitted stably, consistent with findings that exposure to outdoor environmental conditions can accelerate oxidation on electrical and network connectors, thereby increasing the risk of connection failure (Song et al., 2024; Wang & Xu, 2021). Intermittent faults at connector

contacts can also degrade or interrupt data transmission even when power is present (Shen et al., 2017).

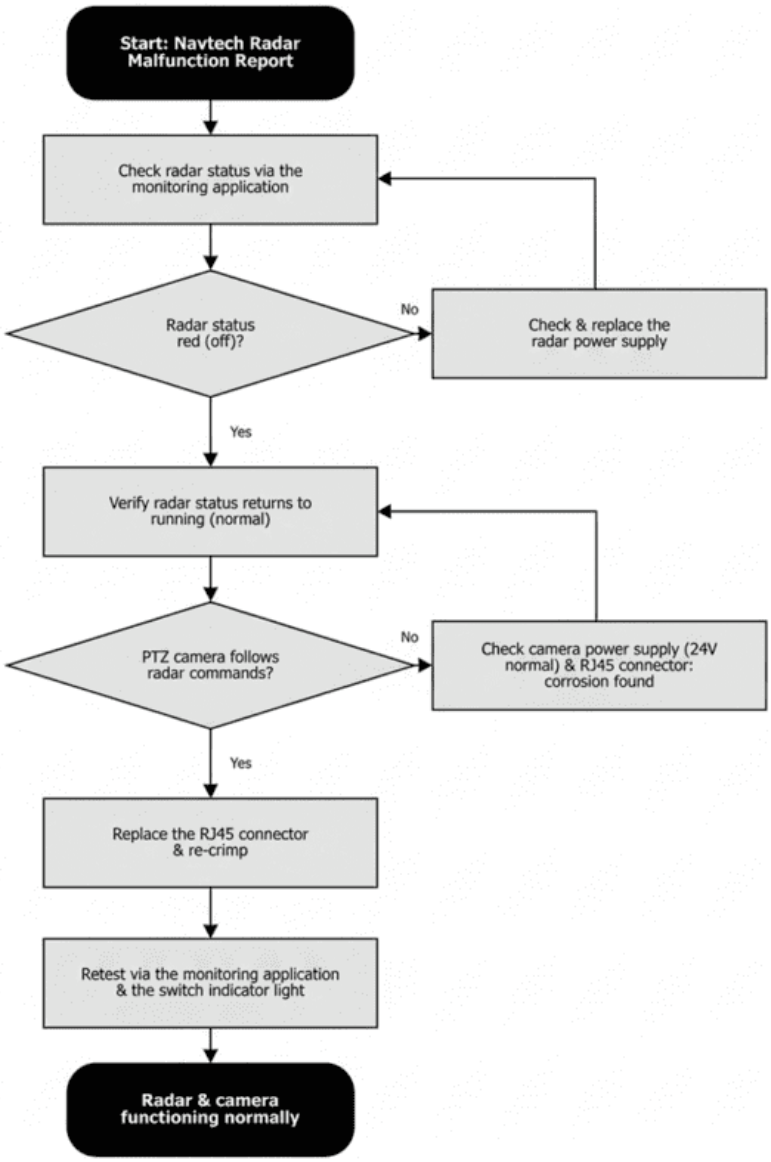


Figure 1 Flowchart of the Navtech Radar PIDS Malfunction Diagnosis and Handling Process (Source: Processed by the Authors, 2025)

Handling and Repair Verification

The repair was carried out by replacing the corroded RJ45 connector with a new connector, then reattaching it to the camera network cable using a crimping tool, following the standard cabling pin order. After the crimping process was completed, the cable was reconnected to the network switch, and a retest was performed, which showed the LED indicator on the switch lit green again,

indicating the cable path was properly connected. Final verification was carried out through the monitoring application, which showed the Navtech radar could be monitored normally and the PTZ camera could once again follow the radar's commands as intended.

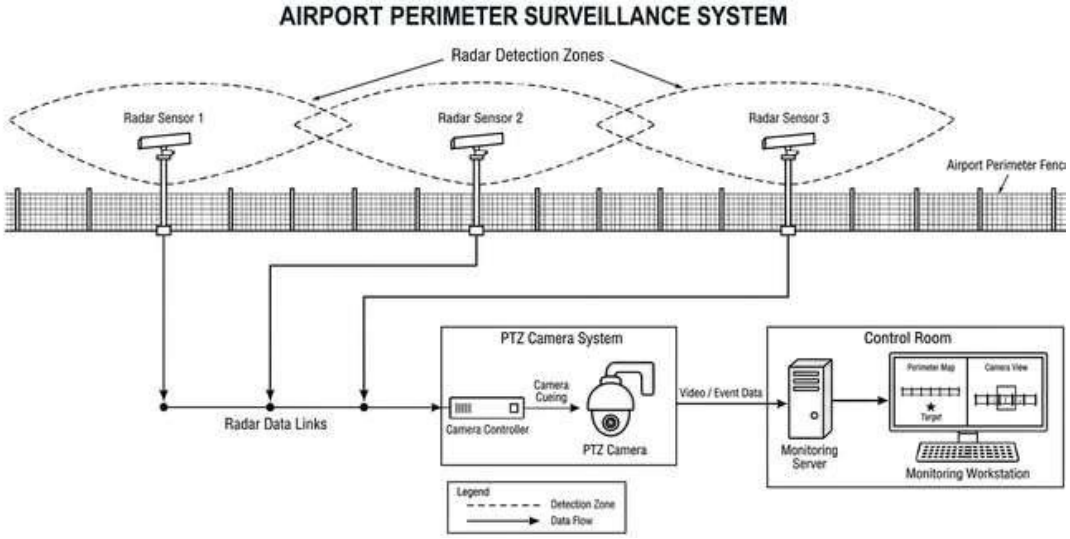


Figure 2 Conceptual Illustration of the Navtech Radar PIDS System in Airport Perimeter Security

Figure 2 presents a conceptual illustration of the Navtech Radar PIDS system, showing the placement of radar sensors along the perimeter fence together with their integration with the PTZ camera and the monitoring server, as a visual complement to the explanation of the system's working principle described in the previous section.

Comparison with Other Perimeter Security Technologies

Besides radar, other technologies commonly used in airport perimeter security include fiber-optic sensors that detect vibration on the perimeter fence (Liu & Lu, 2015) and active infrared sensors to detect movement along a specific path. Laser-based detection has also been proposed for airport perimeters (Wu et al., 2017), and distributed fiber-optic sensors have been studied with a focus on event classification and nuisance-alarm mitigation (Mahmoud et al., 2012). Compared with these technologies, radar offers wider monitoring coverage and can be integrated directly with a PTZ camera for automatic visual verification, although it still requires reliable supporting components such as the power supply and cable network to function optimally (Salem & Hosseny, 2024). The overall effectiveness of an airport security system also depends on equipment quality and the consistent application of Standard Operating Procedures (SOPs) by AVSEC officers (Ulfa, 2022).

Importance of Preventive Maintenance of Outdoor Electronic Equipment

This case study shows that faults in the PIDS system do not always originate from damage to the radar itself, but can also be caused by the failure of supporting components such as the power supply and network connectors continuously exposed to outdoor environmental conditions. Research on electrical connector reliability shows that external vibration and environmental exposure on outdoor power connectors can accelerate the degradation of current-carrying performance, making periodic monitoring of connector state of health an important step in preventive maintenance (Zhang et al., 2025; Song et al., 2024). Determining the optimal preventive maintenance period, including for power supply and network connector components on outdoor equipment, has been shown to reduce expected downtime while improving overall equipment reliability (Al-Duais et al., 2022). Diagnostic and prognostic approaches for switched-mode and uninterruptible power supplies have likewise been proposed to detect degradation before a failure interrupts operation (Li et al., 2014; Saponara, 2016).

Operational Implications and Improvement Recommendations

The findings of this case study have broader implications for the management of all PIDS-supporting electronic equipment installed outdoors along the airport perimeter. Because the radar, camera, power supply, and network connectors all operate outdoors without protection from temperature fluctuations, humidity, and vibration, the risk of component degradation is ongoing, even when not always immediately visible in the monitoring application's status display. This implication is relevant not only to the Navtech radar, but also to other aviation security electronic devices installed in similar locations, such as outdoor CCTV cameras and radio communication equipment.

Based on this single case, the following recommendations are proposed as suggestions that have not yet been tested. First, establishing a periodic inspection schedule for the physical condition of the power supply and network connectors at every PIDS radar point, rather than only waiting for a malfunction report from users. Second, using connectors and enclosures with a higher level of corrosion-resistant protection at points directly exposed to humidity and weather. Third, developing an automated monitoring system that can detect anomalies in the power supply or network connectivity early, before they affect the radar's overall function, in line with the importance of continuous connector state-of-health monitoring (Shen et al., 2017; Song et al., 2024). Fourth, systematically documenting the fault and repair history of each radar unit, so that recurring damage patterns can be identified earlier for long-term preventive maintenance planning. Fifth, strengthening technician competency in recognizing human-

error factors and maintenance-procedure limitations that can slow fault detection, given that the human factor remains an important determinant of the effectiveness of aviation security equipment maintenance (Olaganathan, 2024).

Discussion

This case shows that the functional failure of the Navtech radar in the PIDS system involved two distinct problems occurring in sequence -- the radar power supply failure and the corrosion on the camera network's RJ45 connector -- both originating from electronic-component reliability factors under outdoor operating conditions. The staged diagnostic approach -- checking status through the monitoring application before physical tracing at the site -- proved effective in speeding up initial problem identification without requiring a complete teardown of the system. Given that the PIDS radar is part of the AVSEC system, which must meet reliability standards in accordance with ICAO regulations (Candra Susanto & Keke, 2019), the reliability of this equipment needs to be maintained through periodic preventive maintenance of the power supply and network connectors, particularly for equipment permanently installed outdoors. Implementing a routine maintenance schedule, using corrosion-resistant components, and developing an early-monitoring system can be further steps to reduce the risk of operational disruption to PIDS in the future.

This study has several limitations. First, it covers a single radar unit and a single event, so the findings cannot be generalized. Second, the incident date, the duration of the outage, and any compensating security measures are not reported. Third, the type of measuring instrument and the voltage readings of the radar power supply are not specified, the cause of the power-supply failure was not investigated, and no examination of the failed unit is reported. Fourth, the corrosion of the RJ45 connector is not supported by photographs or contact-resistance measurements, and the location of the connector (outdoor camera side or indoor switch side) is not stated. Fifth, the final verification confirmed monitoring and camera control but did not include a detection (walk) test of the protected zone. Future studies should document these data.

Conclusion

The malfunction of the Navtech radar in the Perimeter Intruder Detection System (PIDS) at Juanda International Airport, Surabaya, involved two sequential problems: a radar power supply failure that caused the radar status to go off, and corrosion on the RJ45 connector of the PTZ camera's network cable that prevented the camera from following the radar's commands. Staged diagnosis through the monitoring application and physical tracing identified both faults in sequence. Replacing the power supply and the RJ45 connector

restored the radar and PTZ camera to normal operation as shown in the monitoring application. These findings are limited to a single case. They indicate that the reliability of the PIDS radar depends on supporting components such as the power supply and network connectors, which are vulnerable to outdoor exposure, so periodic preventive maintenance, corrosion-resistant components, and early-monitoring systems are suggested.

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AI Declaration

The author acknowledges the use of artificial intelligence (AI) tools in supporting the preparation of this manuscript. The author remains fully responsible for the accuracy, originality, and integrity of the research and its findings.

Disclosure statement

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