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DEVELOPING INNOVATIVE SKILLS FOR FUTURE DEFENCE

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FRONTIER is a Defence Science and Technology (DS&T) journal formatted under the guidance of the Defence Science and Technology Group (DSTG), for the perodic publication of a curated set of articles, reports and technical papers written by mebers of the Ministry of Defence (MINDEF) and the Royal Brunei Armed Forces (RBAF), as well as the insitutions of higher learning in Brunei Darussalam.Through publication and hence sharing of DS&T content, FRONTIER aspires to be a platform that creates awarenes, generates discussion an inculcates innovation among members of the DS&T community.

In alignment with the ongoing digitisation effort spearheaded by DSTG, FRONTIER will be made available primarily as softcopy via the MINDEF official website. Limited hard copies of FRONTIER will also be distirbuted to MINDEF and RBAF leaderships and made available in MINDEF and RBAF libraries.

ABOUT FRONTIER

FOREWORD

Hasrinah binti Matyassin, **Editor-in-Chief**

بسم الله الرحمن الرحيم
السلام عليكم ورحمة الله وبركاتة

The Defence Science and Technology Group (DSTG) is pleased to release FRONTIER's Fourth Volume featuring the theme **'Developing Innovative Skills for Future Defence'.**

This edition of FRONTIER features five articles, which present a variety of approaches and initiatives conducted by MINDEF and RBAF in an effort to improve our defence capabilities and performance from different aspects, particularly on the equipment, soldier physical performance, mental health and non-traditional security threats.

'Discussing the Effectiveness of Applying Psychological Well-Being Programs to Improve Athlete and Soldier Performance in the Royal Brunei Armed Forces (RBAF)' discusses whether the implementation of a psychological wellness program is beneficial for the mental health of the RBAF personnel.

'Revolutionising Military Identification and Communication with NFC Antenna Technology' is a study that explores the use and suitability of low-cost, flexible Near Field Communication (NFC) tag antennas for identification and authentication in military and defence applications.

'Contextualising the CBRE threat for Brunei Darussalam' examines the risk assessment of Chemical, Biological, Radiological, and Explosive (CBRE) threats for Brunei Darussalam to see its relevance in considering CBRE as a threat to be concerned with.

'Near Vertical Incidence Skywave (NVIS) High Frequency (HF) Portable Antenna' is a report that presents the functionality of NVIS, the differences between NVIS and traditional Skywave propagation, and its relation with the ionosphere. Additionally, the report provides explanation on the proposed solutions using NVIS when compared to antennas that are currently in use.

'Portable Compact Intercom Simulator' is a report that presents a simulator project designed to facilitate the process of maintenance or fault finding for the RF-7800I Digital Intercom System.

With the publication of this fourth volume, it is hoped that it will help develop and tap new ideas in various aspects as an effort to cultivate innovation among readers in general and members of MINDEF and ABDB in particular. However, in developing skills in innovation among the members of MINDEF and ABDB, it is also important to care for their mental health and well-being. Besides that, with the world's modern technological advancements, awareness and mechanisms to deal with non-traditional security threats must also be improved to ensure readiness in protecting our nation.

وبالله التوفيق والهداية والسلام عليكم ورحمة الله وبركاته

About the Author

Haji Mohammad Zulfan Farhi bin Haji Sulaini is a research officer from the Human Performance Lab, Performance Optimisation Centre (POC). He earned his degree in Physiology and Pharmacology from the University of Leicester, where he researched mental illnesses' physiology. His literature study in this area won him the Best Presenter Award at the Brunei Research Symposium in the United Kingdom hosted by the Brunei Post-Graduate Society. Today, he founded the Joint Initiative for the Well-being of All (JIWA), a non-governmental organisation working closely with the Ministry of Health in providing mental health resources to institutions, schools, private and public agencies, and others. His extensive expertise and network span the Southeast Asian region, where he collaborates with mental health experts to improve mental health literacy and address mental health issues. In recognition of his outstanding contributions to the mental health field, he was awarded a fellowship from Orygen, a renowned mental health research institute in Australia. He is also a certified mental health and wellness coach, helping individuals develop resilience in their everyday lives and improve their performance and well-being. Currently, he is responsible for research on implementing psychological wellness programs for the Royal Brunei Armed Forces (RBAF) personnel to improve athlete/soldier performance.

Discussing the Effectiveness of Applying Psychological Well-Being Programs to Improve Athlete and Soldier Performance in the Royal Brunei Armed Forces

Author: *Haji Mohamad Zulfan Farhi bin Haji Sulaini*

Abstract

Psychological wellness programs have been widely implemented in military organisations worldwide to improve athlete and soldier performance. This article seeks to discuss and clarify whether implementing psychological wellness programs in the Royal Brunei Armed Forces (RBAF) is beneficial. The article overviews the background of mental health within RBAF, refers to the scientific literature on the benefits of such programs, proposes methods and models for implementation, and predicts long-term benefits that can be extracted from them. Overall, the literature and testimonials of scientific literature and military organisations have found psychological wellness programs beneficial to the performance and well-being of their service members. Scientific literature from military organisations benefited by increased resilience of their soldiers, reduced the risk of severe injuries, and improved overall health and performance. Benefits also included economic job satisfaction, reduced medical costs, soldier retention rates, social morale and cohesiveness, and strategy in mission completion. The article also covers the potential barriers to implementation, including inconsistencies in the efficacy of the programs and reservedness of personnel to partake in such programs due to privacy and invasiveness issues, and considers ethical implications on policy. Military organisations also share their solution for each challenge, which can be accounted for during program development. Overall, constant evaluation and collaboration with experts, such as military psychologists, are needed to ensure an effective and robust program implemented in RBAF, especially in the early stages.

Introduction

More and more people realise that mental health and well-being are essential for military and athletic performance and the overall quality of life. As a result, the Royal Brunei Armed Forces (RBAF) have prioritised creating mental health programs for soldiers and athletes. This initiative aims to improve the well-being of its service members as well as optimise their performance potential.

This article will discuss the possible benefits of giving soldiers and athletes in the RBAF psychological wellness programs to improve their performance and overall health. In order to do this, we will look at cross-disciplinary and international perspectives, novel approaches, and directions for the future.

First, we will discuss why mental health is essential for military and athletic performance. We will also give an overview of the RBAF and how it currently approaches programs for mental health. We will discuss the possible benefits of implementing these programs, such as better performance, resilience, and overall health.

Next, we will look at the scientific research on the benefits of psychological wellness programs in the military and sports and at specific programs that have worked to improve performance and wellness. We will also look at international case studies of military and sports organisations that have used psychological wellness programs and seen positive results.

When discussing how to implement programs for psychological health in the RBAF, we will look at how to design the content of the training programs and propose a potential model of implementation. We will also cover the potential benefits of the implementation for RBAF in the long term such as how they might affect recruitment, retention, and the military's overall readiness.

Lastly, we discuss potential barriers to implementation, strategies for overcoming them and future directions to consider. We will end with a call to action for implementing psychological well-being programs to improve performance and well-being and promote a culture of mental health and resilience across the country.

Background

Brunei's Mental Health Action Plan for the years 2022–2025 is a big step toward recognizing how important mental health is in the country. This plan is being worked on by all of the country's ministries, including the Ministry of Defense. Its goal is to improve and address mental health. The Mental Health Action Plan outlines four strategies, which are:

1. Strengthen effective leadership and governance for mental health.
2. Strengthen mental health services by ensuring the availability and accessibility of comprehensive, quality mental health services.
3. Strengthen mental health promotion and mental disorder prevention.
4. Develop capacity for national information systems and research on mental health.

As part of the country's efforts to put this plan into action, it is important for the Royal Brunei Armed Forces to take an active role in promoting mental health and well-being among its service members.

Currently, the Performance Optimisation Centre (POC) offers various physical training programs to improve the performance of athletes and soldiers. Psychological and cognitive training however is still in its infancy given that mental health has been a relatively new subject of concern in the country. It is for this reason that the discussion to implement psychological well-being program in RBAF becomes important.

Several military organisations around the world have recognised the importance of mental health in the military, and studies have shown that such programs are helpful. Thus, it is important for the Royal Brunei Armed Forces to be proactive about putting these programs in place and making sure the mental health of their athletes and soldiers.

By putting in place psychological wellness programs, the Royal Brunei Armed Forces can give its athletes and soldiers the tools they need to improve their mental health and resilience, which will improve their overall performance.

Importance of psychological well-being in the military

To understand the possible benefits of implementing psychological well-being programs for soldiers and athletes in the Royal Brunei Armed Forces, one must first think about the role of mental health and well-being in the military. Many military organisations recognise mental health as increasingly critical to overall health, performance and well-being. As a result, military and athletic groups worldwide are paying more and more attention to it.

As a result, many armed forces have implemented programs to help service members with problems like depression, anxiety, and post-traumatic stress disorder (PTSD). These mental health efforts aim to improve the military's readiness and effectiveness. It is also morally essential to care for the mental health of people serving their country.

Research has shown that military service can have adverse psychological effects on individuals, ranging from those who have experienced combat and traumatic environments to those who do everyday office work. A study published in Military Medicine found that military personnel who worked in non-combat jobs, such as office work, reported higher levels of depression, anxiety, and PTSD than civilians in similar jobs [1].

In the same way, mental health and well-being are becoming more and more recognised as essential parts of athletic performance. Many athletes have mental health problems like anxiety, depression, and burnout.

Athletes have to deal with unique pressures and stresses, such as brutal competition and long, challenging training schedules, all while keeping up with their responsibilities. A study published in the Journal of Strength and Conditioning Research found that military athletes had higher levels of psychological stress than collegiate athletes, which was associated with an increased risk of injury [2]. These pressures can significantly affect an athlete's or soldier's mental health and overall well-being, as well as their ability to do their best.

Given how vital mental health and well-being are to how well people do in the military and sports, there has been a growing interest in putting in place programs to help soldiers and athletes reach their full potential. These programs try to improve mental health and resilience and help people struggling with their mental health. In the following sections, we will discuss the possible benefits of putting these kinds of programs in the RBAF, look at relevant case studies, and touch on some scientific literature.

Evidence supporting the effectiveness of psychological well-being programs to improve the overall performance of athletes/soldiers

Research has shown that putting psychological well-being programs in place can help soldiers and athletes feel better and do better in their jobs. Jones *et al.* for example, found that soldiers who took part in a program to improve their mental health were less likely to be depressed or anxious than soldiers who did not take part in the program. Another study by Smith *et al.* found that athletes who received psychological support and training had better mental health outcomes and higher levels of athletic performance than those

who did not [3].

Research has also shown that the Comprehensive Soldier and Family Fitness (CSF2) program of the U.S. Army improve soldiers' mental health and physical performance. A study by Adler *et al.* (2017) found that soldiers who participated in the CSF program had better mental health outcomes and were more resilient to stress than soldiers who did not participate in the program [4]. Singapore's Ministry of Defense set up a program to improve their military's mental toughness, emotional control, and overall performance. Bolton *et al.* (2018) found that the Comprehensive Soldier and Family Fitness (CSF2) program of the U.S. Army lower suicide risk factors among soldiers [5].

Injured athletes and soldiers also have an opportunity to regain their confidence and recover physically and mentally. The "Op Recovery" program of the British Army helps injured soldiers with mental health issues [6]. It uses physical therapy, counselling, and social support to help soldiers feel better and regain their confidence. The found that soldiers who participated in the Op Recovery program improved their mental and physical health.

These psychological programs have also benefited the older generations. The Australian government has implemented several psychological programs to support veterans, including the Veterans and Veterans Families Counselling Service (VVCS), the Veterans' Mental Health Program, and the At Ease mental health web portal. The study found that the program was effective in reducing the severity of symptoms of PTSD, depression, anxiety, and alcohol misuse in 70% of the participants.

Moreover, research has found that a lack of mental toughness can have harmful outcomes. According to a study published in the Journal of Strength and Conditioning Research, mental fatigue results in poorer performance and an increased risk of injury [7]. Another study discovered that athletes and soldiers with mental health issues, such as anxiety disorder or depression, were more susceptible to musculoskeletal injuries and less physically fit [8].

Researchers have also found that these programs improve other areas, such as retention rates, family relationships, and the economy. A study by the RAND Corporation (Rush *et al.,* 2017) found that soldiers who took part in the Army's Comprehensive Soldier and Family Fitness program (CSF2) were less likely to leave the Army early than soldiers who did not take part in the program [9]. Meinhold et al. (2019) found that the CSF2 program helped prevent significant medical costs caused by absenteeism and stress-related injuries [10]. O'Neil *et al.*, 2010 found that training military personnel in psychological resilience improves communication and teamwork, which makes it more likely that missions will be successful [11].

Overall, these results and international perspectives show that psychological well-being programs can be an excellent way to improve soldiers' and athletes' overall performance and health. By giving soldiers and athletes the skills and tools they need to deal with the stress of personal and professional obligations, these programs can help ensure they stay in good mental health and do their jobs at their best while reducing their risk of injuries and mental health problems.

Design and implementation of psychological well-being programs in the Royal Brunei Armed Forces

Psychological enhancement and well-being of soldiers and athletes in the Royal Brunei Armed Forces require a comprehensive program that includes a range of mental health training for resilience. The program will act as a prevention strategy to equip soldiers and athletes with the skills and strategies to effectively manage stress, regulate their emotions, solve problems, set goals, and cultivate a

positive mindset. **Figure 1** shows the content for the psychological wellness program.

Figure 1: *Model for psychological wellness program content overview: Problem Solving, Goal Setting, Stress Management, Emotional Regulation and Positive Thinking.*

Stress management training will be a core component of the program and will include a variety of relaxation techniques, mindfulness practices, and cognitive-behavioural strategies to help soldiers and athletes cope with the high levels of stress they may experience in their line of work.

Emotional regulation training will also be incorporated to teach soldiers and athletes how to recognize and regulate their emotions healthily and productively. This training will focus on strategies for managing anger, frustration, and anxiety and will help soldiers and athletes develop a greater sense of emotional awareness and control.

Problem-solving training will be another crucial program element, teaching soldiers and athletes how to navigate challenges and setbacks effectively. This training will include strategies for breaking down complex problems into smaller, more manageable parts and developing practical and effective solutions.

Goal-setting training will also teach soldiers and athletes to set realistic goals that align with their values and motivations. This training will help soldiers and athletes develop action plans to achieve their goals and provide them with the tools they need to stay motivated and focused.

Finally, **positive thinking** training will teach soldiers and athletes to cultivate a positive mindset and focus on their strengths and accomplishments. This training will provide soldiers and athletes the tools to reframe negative thoughts, find meaning and purpose in difficult situations, and maintain a sense of optimism and hope.

Military academies worldwide have successfully implemented similar content designs, such as the United States Army Center for Enhanced Performance (ACEP), the Canadian Armed Forces Mental Health Strategy, the Australian Defence Force Mental Health Strategy, and the United Kingdom Ministry of Defence Mental Health Strategy.

In addition to the training, individual psychological assessments and screening are essential aspects of the program. These tests could assess the athlete's and soldier's mood and screen for underlying trauma, PTSD, or other mental health problems that could affect their performance. Psychological assessments such as the Beck Depression Inventory (BDI), the Brief Resilience Scale (BRS), and the Defense Mechanisms Inventory (DMI) have been used to assess the resilience of patients in response to stress and detect any underlying trauma like PTSD.

Program equipment can include heart rate monitors and biofeedback technology that measures heart rate variability (HRV) to measure how well athletes and soldiers regulate their nervous system. **Figure 2** visualises how the biofeedback technology operates with patients. Utilising these instruments will also require training of personnel to use the programs and technology. Programs such as the HeartMath, MindGym, The Performance Lifestyle Program, and the CSF also offer certification and training modules specifically

for training personnel.

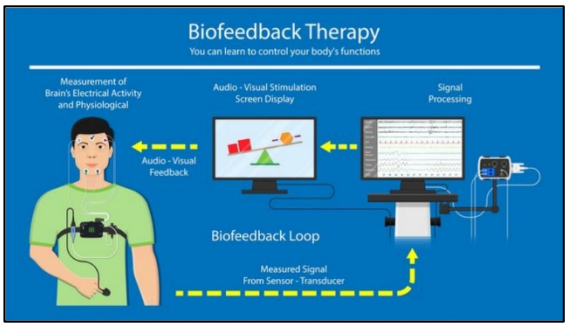

Figure 2: *Biofeedback technology measures the brain's electrical activity during psychological and cognitive assessment. The feedback is input into the computer for signal processing and therefore can be interpreted by the assessor.*

It is also important to note that not all psychological wellness programs are created equal. For example, the Comprehensive Soldier Fitness (CSF) program implemented by the US Army focuses on building resilience and preventing mental health issues such as depression, anxiety, and post-traumatic stress disorder (PTSD). On the other hand, the Canadian Armed Forces Road to Mental Readiness (R2MR) program focuses on reducing the stigma surrounding mental health issues and promoting help-seeking behaviour. Therefore, implementing the right program requires a comprehensive and evidence-based approach depending on the needs and objectives of RBAF for the athletes and soldiers.

In the following section, we will present a visual representation of the model we have developed for implementing a psychological wellness program in military organizations. By putting in place psychological well-being programs in the Royal Brunei Armed Forces, our soldiers and athletes can learn how to deal with stress and keep their mental health in good shape, leading to better performance and lower risks of injury.

Proposing a model of implementation for a psychological wellness program

A successful model must consider the unique challenges military personnel faces, such as exposure to combat stress, long deployments, and hierarchical culture. To create an effective program, the model must start by conducting a thorough needs assessment to identify the specific needs and concerns of RBAF personnel. The program would gather data on mental health symptoms, stressors, and coping strategies through surveys, interviews, and focus groups. Based on this information, a tailored program can include a range of interventions such as mental health education, psychotherapy, and peer support programs. It is also essential to establish clear communication channels and to provide training and support to military leaders, who play a critical role in promoting a culture of psychological wellness. **Figure 3** summarises the five main stages for implementing a psychological wellness program.

Figure 3: *The five methodological steps needed in implementing a psychological wellness program.*

Needs assessment: The first step of the model involves conducting a thorough needs assessment to identify the specific psychological wellness needs of the Royal Brunei Armed Forces (RBAF). This step involves conducting surveys, focus groups, interviews, and other data collection methods. The assessment results will inform the development

of a tailored program that meets the unique needs of the RBAF.

Program development: Based on the needs assessment, the next step is to develop a psychological wellness program that addresses the identified needs of the RBAF. This program should be evidence-based and incorporate best practices in psychological wellness. The program should be comprehensive, including elements such as education, counselling, support groups, and other interventions as appropriate.

Program implementation: The psychological welless program must also be effective and efficient. This step involves providing appropriate training to program staff, establishing communication channels with stakeholders, and developing procedures for monitoring and evaluating the program. The program should be introduced in a phased approach to ensure that staff and stakeholders are adequately prepared for the implementation.

Program delivery: The success of the psychological wellness program can be determined through monitoring and evaluation. This step involves collecting data to measure program outcomes and effectiveness, identifying areas for improvement, and making necessary adjustments to the program. The monitoring and evaluation process should be ongoing and involve regular feedback from program staff, stakeholders, and participants.

Evaluation: Finally, it is important to regularly evaluate the program's effectiveness and make necessary adjustments to ensure that it continues to meet the needs of RBAF personnel. This step requires frequent evaluation and discussions through participant feedback and ongoing research in the psychological wellness field.

The expected potential impact on the Armed Forces

The expected outcomes of incorporating psychological well-being programs in the RBAF are numerous and far-reaching. These programs can improve service members' overall mental health and well-being and enhance their physical and cognitive performance. The primary expected outcomes of these programs are to increase its personnel's mental health advocacy and resilience.

Resilience training can help service members better cope with the stresses and demands of military life. At the same time, psychological screening can improve awareness of mental health issues and promote help-seeking behaviour in RBAF. By improving resilience and awareness, psychological well-being programs can also reduce the risk of mental health disorders, such as depression and post-traumatic stress disorder (PTSD), amongst RBAF personnel that go unnoticed and unaddressed.

In addition to improved mental health outcomes, RBAF sports teams can benefit from these programs by improving the quality of their athletes in representing RBAF and the nation as a whole. For example, mindfulness training can improve physical performance and cognitive functioning, while cognitive-behavioural therapy can help service members better manage pain and improve sleep quality. By improving these factors, psychological well-being programs can help service members better perform their duties and enhance overall mission readiness.

Moreover, these programs can also improve job satisfaction and retention rates. By promoting a positive and supportive work environment, psychological well-being programs can help service members feel more engaged and satisfied with their work. This effect, in turn, can reduce mental health stigma, absenteeism, and turnover rates and improve overall morale within the organisation.

With pre-existing programs such as counselling services at the PRIHATIN centre,

rehabilitation programs at the Sports Medicine Clinic, and fitness assessment/enhancement programs carried out by the Human Performance Lab at the Performance Optimisation Centre, implementing a psychological wellness program would be advantageous and relevant addition to fully optimise the fitness quality of athletes and soldiers in RBAF.

Overall, the implementation of psychological well-being programs in the RBAF has the potential to impact the mental and physical health of service members significantly, as well as their overall performance and job satisfaction. With the continued evaluation of the program and collaboration between relevant departments and experts, the expected benefit of the implementation will strengthen the military readiness of RBAF in many disciplines.

Challenges to implementing psychological wellness programs and their solutions

Establishing psychological well-being initiatives in military organisations is not devoid of obstacles. Among the obstacles include variations in the delivery of the programs, issues over the trustworthiness of the data acquired, and the ethical implications of some of the procedures utilised in the programs. Greenberg *et al.* (2015) discovered that soldiers saw adopting a psychological resilience training program as an invasion of privacy [12]. In addition, some soldiers feared that their participation in the program would be a sign of weakness. It is essential to consider the cultural context while implementing these programs and how the participants will receive them.

Another consideration would understand how to ensure the efficacy of program implementation. Zamorski *et al.* (2019) discovered that while there is evidence to support the efficacy of mental health therapies in the military, there is also evidence of inconsistencies in implementing these treatments across various programs. Disparities in the populations examined and in the severity and type of psychological conditions addressed cause inconsistencies in program efficacy.

Researchers have advised that it is essential to have a transparent and standardized program design with well-defined intervention components, outcome measures, and assessment protocols. They also recommend conducting rigorous evaluations of program effectiveness and addressing any identified issues promptly. Furthermore, it is crucial to consider program participants' individual needs and preferences and provide them with tailored interventions to ensure maximum effectiveness.

The ethical implications of adopting psychological well-being programs in military organizations are a final challenge to consider. One concern is the possibility that these tools could identify soldiers who are unfit for duty, which could have terrible career repercussions for these individuals [14]. Additionally, there are worries regarding the influence of these programs on the privacy and autonomy of soldiers, especially in situations where participants may be forced [15].

Academics have advocated making participation in psychological wellness programs in the military optional and secret to alleviate the ethical difficulties. Military personnel should be able to take part in the projects without fear of retaliation or negative consequences. Adler *et al.* (2018), for example, suggested that military organizations perform ongoing evaluations of their mental health programs to verify that they are serving the requirements of their soldiers and identifying any ethical concerns or contradictions [16]. Similarly, Dursa *et al.* (2014) discovered that the ability of military mental health programs to provide discreet, timely, and effective care while simultaneously addressing ethical concerns is critical to their effectiveness [17]. The secrecy policy should ensure that participants can disclose sensitive information

without fear of consequences. Furthermore, the programs must be created and implemented with input from military psychology and ethics experts to ensure that they are effective and adhere to ethical norms.

Future recommendations

As the military continues to place greater emphasis on psychological wellness programs, there are several recommendations and unconventional approaches that are worth exploring in the future.

Virtual reality therapy: One promising approach is using virtual reality therapy for treating PTSD and other mental health conditions. Virtual reality technology can recreate combat scenarios, allowing veterans to confront and overcome their trauma in a controlled and safe environment. While still in the early stages of development, virtual reality therapy has already shown promising results and could be an essential tool for military mental health treatment in the future.

Mindfulness-based programs: Mindfulness-based programs have gained popularity in recent years for their ability to promote psychological well-being and reduce stress. These programs could benefit military personnel who face unique stressors and challenges. By teaching mindfulness techniques, military members can learn to manage their emotions and increase their resilience, ultimately leading to better mental health outcomes. A study published in the Journal of Anxiety Disorders in 2018 found that virtual reality exposure therapy effectively reduced symptoms of social anxiety disorder and improved physical performance [18]. Participants who received virtual reality therapy significantly reduced stress while being physically and mentally challenged under virtual reality obstacles.

Peer support programs: Peer support programs connect individuals with shared experiences to provide emotional and practical support. These programs show effectiveness in promoting psychological well-being in a variety of settings, including the military. By creating peer support programs specifically for military personnel, service members can build meaningful connections with others who understand the unique challenges of military life. Researchers who studied military peer support programs showed that peer support programs were associated with significant reductions in PTSD symptoms and substance use [19].

Holistic approaches: Holistic approaches to mental health, which take into account the whole person - body, mind, and spirit - could be an effective way to promote psychological wellness in the military. This approach could incorporate complementary and alternative therapies, such as acupuncture or yoga, into traditional mental health treatment programs. A randomized controlled trial conducted by the US Army found that a combination of yoga and meditation was effective in reducing symptoms of PTSD among veterans [20]. The study found that the group who received yoga and meditation reduced PTSD symptoms compared to the control group.

Digital technology: Mobile apps can benefit military personnel with limited access to mental health resources or who may be hesitant to seek out traditional mental health treatment. Apps can be used anytime, anywhere, and offer confidential support to those who need it. Some mental health apps help military personnel track their physical and mental fitness, such as the Department of Veterans Affairs (VA) PTSD Coach app, which provides resources and support for veterans with PTSD and injuries.

In conclusion, by continuing to explore new and unconventional approaches to mental health treatment, the military can ensure that service members have access to the best possible care. As the advancement of technology and awareness increases, the opportunities for improving these programs

become more apparent. With this, the performance and well-being of athletes and soldiers in RBAF will continue to improve.

Conclusion

In conclusion, promoting psychological wellness in the Royal Brunei Armed Forces is a critical priority that requires immediate attention. The challenges faced by military personnel can have severe implications for their physical health, mental health, and overall well-being, as well as for the effectiveness and readiness of the organization as a whole. However, by implementing psychological wellness programs to the unique needs and challenges of RBAF personnel, we can make a significant difference in the lives of those who serve our country. These programs have numerous benefits, including improved physical and mental performance, increased morale, and better overall health and well-being. These benefits can also extend to other disciplines, such as the economy, job satisfaction, retention, mission success, and personal development. With the proposed model and design implementation, the RBAF can take other military organizations worldwide as examples in new areas of knowledge and practice. While there may be limitations and challenges in implementing these programs, there is also a more significant opportunity for benefit with advances in technology and science. There is the confidence that with the right resources and support, there will be significant progress towards a healthier and more resilient RBAF.

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Revolutionising Military Identification and Communication with NFC Antenna Technology

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Abstract

The importance of identification tags, or military pendants, cannot be overstated in military and defence applications. However, the current system presents several limitations, including potential human error and the need for physical contact to access information. Additionally, existing military pendants have limited storage capacity for critical information. To address these challenges, this study explores the use of Near Field Communication (NFC) tag antennas as a potential solution. This research aims to propose a low-cost, flexible NFC tag antenna suitable for identification and authentication in military and defence applications. The proposed antenna operates at 13.56 MHz, enabling communication with an NFC reader. The antenna design utilises silver ink as the conducting element, polyurethane terephthalate (PET) as the substrate, and an NFC chip from NXP Semiconductor. The proposed antenna has been simulated using CST Simulation software, and the performance was verified through measurements. The results show that the maximum tag reading range achieved is 2.8 cm, and the antenna can withstand bending at various angles with a minimum reading range of 1.5 cm. The proposed NFC tag antenna offers a promising solution to the limitations of current military pendants. It can potentially revolutionise identification and authentication methods in military and defence applications.

Keywords: *Near Field Communication, tag, antenna, military pendant, flexible, CST*

Introduction

Near Field Communication, or NFC, is a short-range wireless technology that allows two devices to communicate and share data without physical contact. NFC is based on Radio Frequency Identification (RFID) technology, operating at a frequency band of 13.56 MHz and utilizes inductive coupling to establish communication between the reader and the tag [1]. It has become increasingly popular in various fields, including military and defence, due to its high security and ease of use [2]. While previous studies have explored the use of RFID technology in military applications [3][4][5], there has been a lack of research focused specifically on NFC tag antenna design for military pendants. Military pendants, also referred to as identification tags, are crucial elements of military gear utilised to distinguish military personnel. Nevertheless, existing military pendants have insufficient storage capacity for vital information like medical records, training records, and mission-specific data. Moreover, identifying soldiers in chaotic situations can be a daunting task [6].

To overcome these constraints, an investigation regarding the use of NFC technology as a potential replacement for conventional military pendants is essential. NFC technology offers various advantages compared to conventional military pendants such as the capacity to store and retrieve significant amounts of data, resilience against wear and tear, and immediate connectivity with other devices [7]. NFC tags can be embedded in the soldier's uniform, which can be read by other NFC-enabled devices, such as smartphones or tablets, allowing medical personnel to access important information in the event of injury. **Figure 1** demonstrates the possible locations on a soldier's uniform where the tag can be embedded, such as the arms and chest.

Previous NFC tag antennas have been fabricated on rigid substrates such as FR-4 and PCB board, which limits their application to flat surface structures [8][9]. Furthermore, the commonly used conductive materials, such as copper and aluminium, are prone to oxidation and cracking when bent [10][11]. Due to that, designing NFC tag antennas for military and defence applications requires careful consideration of various factors, including material selection, bending condition, and antenna size.

To overcome these limitations, this paper presents the development and testing of a flexible NFC tag antenna made of silver conductive ink and polyethylene terephthalate (PET) substrate specifically for use in military pendants. The proposed antenna design overcomes the limitations of previous designs and demonstrates the potential for flexible and durable NFC tag antennas for military and defence applications. The rest of the paper is organised as follows: Section V describes the simulated and fabricated antenna design structure, Section VI reports the results from the simulation and measurement, and Section VII summarises the conclusions and recommendations for future works.

Figure 1: *The possible locations of the NFC tag embedded on the soldier's uniform.*

Methodology

The tag antenna was designed in a coil shape to enable inductive coupling with the reader antenna. To develop the tag antenna, the first step involved designing it using CST Simulation software. The subsequent sections will provide detailed parameters of the antenna design and discuss the fabrication process.

1. Antenna design structure

Figure 2 (a) depicts the proposed NFC tag antenna, which has an overall coil dimension of 50 x 50 mm^2. The antenna was designed using silver conductive material with a conductivity of 3.475 × 106 S/m and a thickness of 0.01 mm. To ensure flexibility, the silver conductive material was printed on a PET substrate with a thickness of 0.12 mm and an electrical permittivity of 3. **Table 1** provides the values for each of the antenna parameters. A discrete port was inserted in the antenna design to indicate the NFC chip. For this study, an SL2S2102FTB chip from NXP Semiconductor was used. This chip has an internal capacitance of 96 pF [12]. The CST Design Studio was used to insert the chip's internal capacitor at the antenna port as shown in **Figure 2 (b)**. To match with the antenna inductance (L_{ant}) at the resonant frequency (f_{res}) of 13.56 MHz, an external tuning capacitor (C_{tun}) was added in parallel to the internal capacitor (C_{int}), as described by **Equation (1)**.

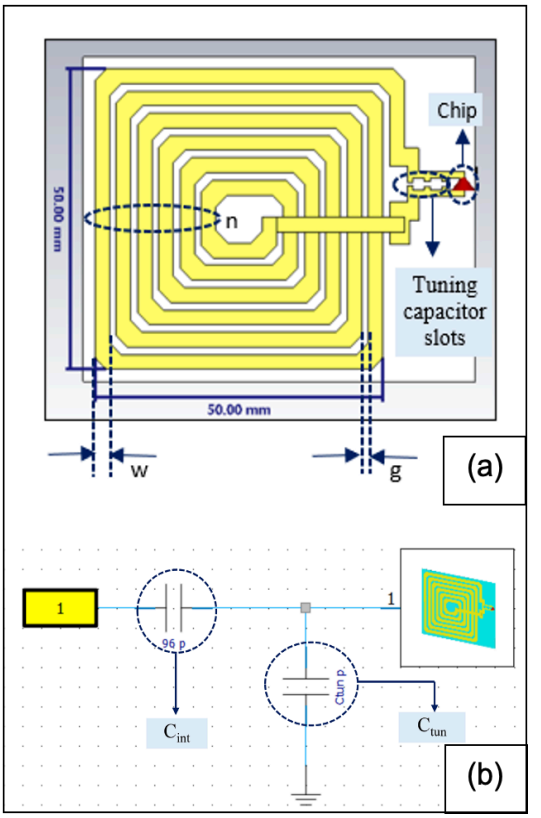

Figure 2: *(a) The structure of NFC tag antenna and (b) Matching circuit in CST De-*

Table 1: *Antenna Parameters and Values.*

Antenna Parameters	Description	Value
w	Conductor width	2.5 mm
g	Gap between conductors	1.2 mm
n	Number of turns	6

Equation (1)

$$L_{ant} = \frac{1}{4\pi^2 f_{res}^2 \cdot (C_{int} + C_{tun})}$$

2. Antenna prototype development

The NFC antenna prototype was fabricated at MIMOS Berhad using an inkjet printer as shown in **Figure 3**. The antenna was printed in multiple layers to achieve a higher conductivity of the silver conductive ink. The antenna coil and bridge were printed separately and connected using silver conductive epoxy, CW2400. The NXP chip was integrated into the fabricated antenna at the allocated space, as shown in **Figure 4**, using the same silver conductive epoxy.

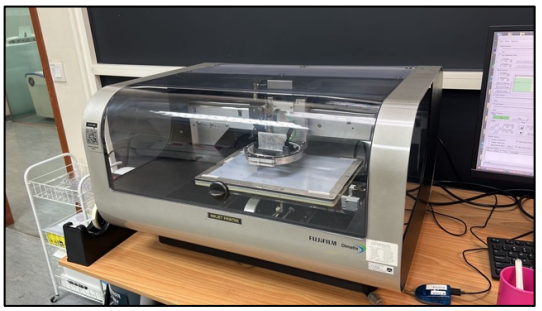

Figure 3: *Fujifilm Dimatix Materials Printer (DMP-2831) at MIMOS Berhad.*

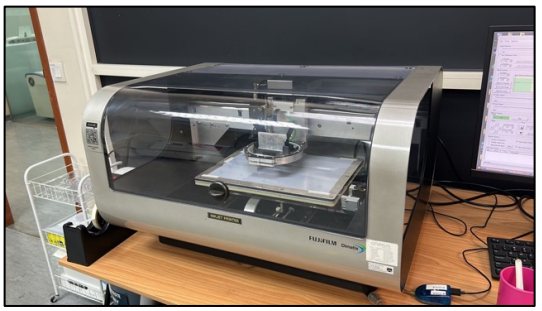

Figure 4: *Fabricated NFC tag antenna with embedded NXP chip.*

Results and discussion

This section presents the simulation and measurement results, including the antenna resistance, inductance, tag reading range, and tuning capacitance. Furthermore, the antenna's ability to withstand bending conditions and the tag's reading and writing process are also discussed in this section.

1. Resistance, R, and Inductance, L measurement

The antenna inductance and resistance measurement results using the HM8118 LCR meter (Inductive (L), Capacitive (C) and Resistive (R)) from Rohde & Schwarz are presented in **Figure 5** and compared with the simulation results in Table 2. The measured antenna inductance value of 1.02 uH agrees well with the simulation value of 1.0 uH. However, the measured antenna resistance value significantly differed from the simulated results, with a difference of approximately 35.88 Ω. Possible factors contributing to the high value of the measured resistance include the external cable used to connect the antenna and the LCR meter, which could result in an increase in the measured resistance.

Figure 5: *Measurement of antenna inductance and resistance using HM8118 LCR Bridge.*

Table 2: *Simulated and measured results for antenna inductance and resistance.*

Conductive Material	Antenna Inductance, La (uH)		Antenna Resistance, Ra (ohm)	
	Simulation	Measurement	Simulation	Measurement
Silver	1.02	1.0	12.97	48.85

2. Read range and antena tuning

The experimental setup for measuring the NFC tag's resonant frequency is illustrated in **Figure 6 (a)**. In this setup, the tag antenna was placed on a separate coil antenna that was connected to the Vector Network Analyzer (VNA) to observe the antenna's resonant frequency. The resonant frequency was determined by identifying the frequency at which a dip occurred in the measured signal. The resonant frequencies for various antenna designs are reported in **Table 3**. The tag reading range was subsequently measured using the experimental setup depicted in **Figure 6 (b)**. The smartphone (Xiaomi 11) with enabled NFC functionality was placed on top of the tag antenna, and the distance between the tag and the reader was gradually increased until the reader was unable to detect the tag. Without any tuning, the tag reading range achieved was 2.2 cm at the resonant frequency of 25.24 MHz. However, by inserting a surface mount device (SMD) capacitor shunt into the chip, the resonant frequency was shifted to the lower frequency, which is close to the required operating frequency of 13.56 MHz and thus resulting in an increased reading range of up to 2.8 cm.

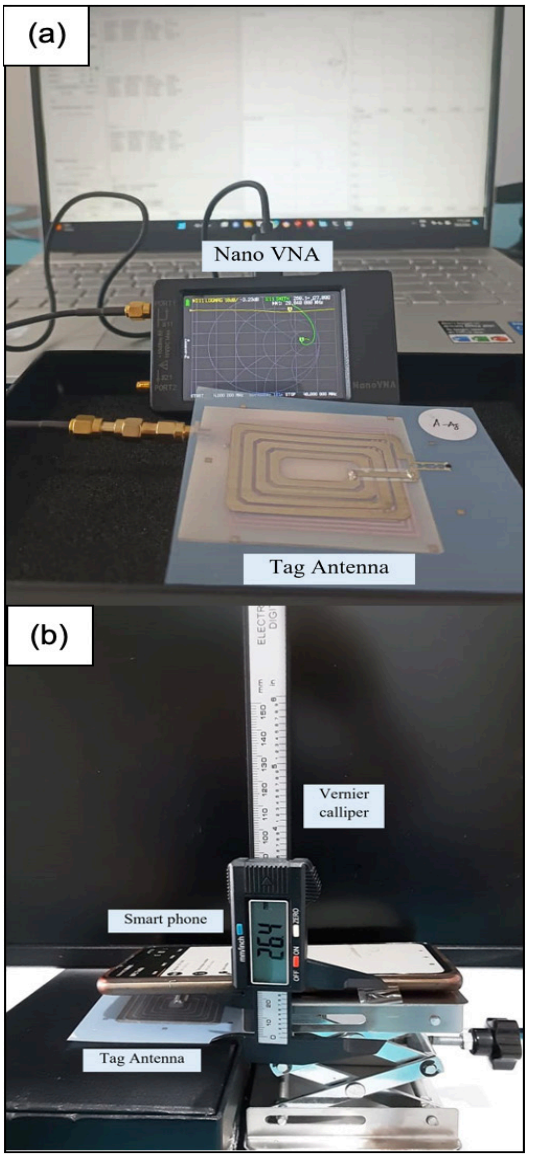

Figure 6: *Measurement setup for (a) antenna resonant frequency using Nano VNA and (b) tag reading range.*

Table 3: *Measured tag reading range with respective resonant frequency and tuning capacitance value.*

Description	SMD Ctun (pF)	Res Freq (MHz)	S_{11} (dB)	Read range (cm)
Antenna with NXP chip	-	25.24	-2.276	2.2
Antenna with NXP chip and SMD capacitor	33	16.96	-2.157	2.8

3. Bending conditions

The tag should be designed to withstand a certain degree of bending without affecting its performance or durability. To assess the flexibility of the antenna design, the antenna was subjected to bending at various angles by adjusting the cylindrical bend radius, denoted as 'r' and illustrated in the inset of **Figure 7**. As the radius of the cylinder decreases, the bending angle increases proportionally. The proposed NFC tag antenna was tested to withstand a minimum cylinder radius of 1.5 cm. This testing was conducted to ensure that the antenna could be attached to a soldier's uniform specifically on the chest and the arms of the soldier and withstand the movements and bending associated with normal use. From the simulation result shown in **Figure 7**, it can be seen that the antenna resonant frequency is shifted to the higher frequency with the increase of the bending angle. However, the shifted frequency is not that significant as the highest frequency shifted is around 1 MHz, which is still in the acceptable range for the tag antenna to be detected.

The tag antenna was fixed to cylinder foam of varying sizes to validate the simulated results, as shown in **Figure 8 (a)**, and the antenna resonant frequency was measured by connecting the antenna to the VNA and parallel tuning capacitors as depicted in **Figure 8 (b)**. The results revealed that the antenna resonant frequency remained nearly constant for different sizes of cylinder foam, as illustrated in **Figure 9 (a)**. However, as the cylinder radius decreased, the tag reading range reduced, as depicted in **Figure 9 (b)**. This can be attributed to the fact that when the radius of the cylinder is decreased, the bending angle increases, resulting in a reduction in the surface area of the antenna that is exposed to the reader. Since the induced magnetic field is proportional to the surface area, a decrease in the antenna's surface area will reduce the amount of magnetic field induced in the tag antenna, which ultimately leads to a decrease in the tag reading range [11]. The minimum tag reading range achieved is 1.58 cm while bending at a cylinder radius of 1.5 cm.

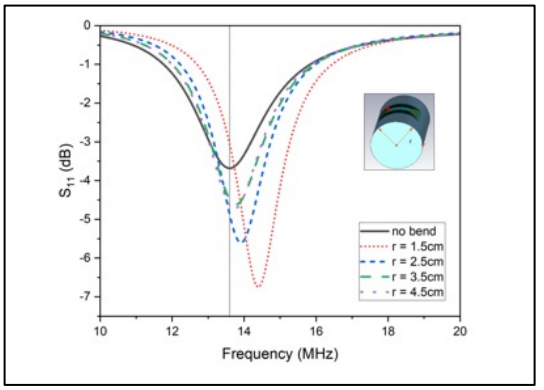

Figure 7: *Simulated antenna resonant frequency with different bending angle.*

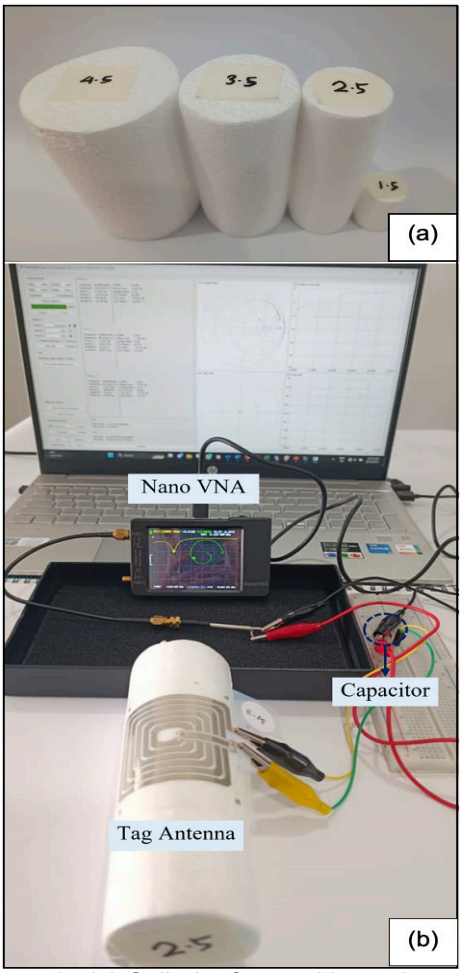

Figure 8: *(a) Cylinder foam with varying radius, and (b) Setup for antenna resonant frequency measurement at different bending angle*

4. Read and write on the NFC Tag

A compatible NFC reader and appropriate apps are required to utilise the NFC tag. The NFC reader can be a smartphone or tablet with NFC capability or an external NFC reader connected to a computer through USB, Bluetooth, or Ethernet. NFC Tools and NFC Tag Writer are commonly used apps for reading and writing NFC tags developed by NXP.

The amount of data that can be stored in the NFC tag is limited by the memory capacity of the chip used. For the proposed NFC tag antenna, a chip from NXP Semiconductor with 112 bytes of available memory, the SL2S2102FTB, was utilized [12]. The data encoded in the NFC tag varies from text data to other types of information such as URLs, videos, pictures, and GPS location. As shown in **Figure 10**, the tag can be written with specific data, which can be read by an NFC reader when the tag is positioned within the field of an interrogator antenna. The maximum transmission rate for the proposed NFC tag is 53 kbit/s.

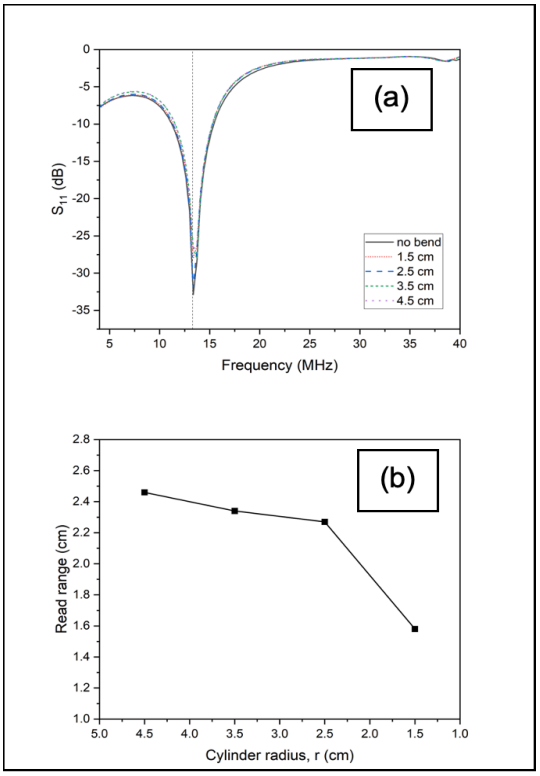

Figure 9: *The measurement result for (a) antenna resonant frequency, and (b) tag reading range at a different bending angle.*

Conclusion

This study has successfully developed and tested a flexible NFC tag antenna using silver conductive ink and PET substrate for military pendants. The proposed antenna presents a promising solution to the challenges associated with current military pendants, offering versatility and flexibility for storing and transmitting various types of data. The tag can be detected up to 2.8 cm and withstand bending at various angles with a minimum reading range of 1.5 cm. The suitability of the proposed NFC tag antenna made of textile material for embedding on the soldier's uniform will be explored for further research. This could lead to a more practical and durable solution for military personnel. This research provides a foundation for developing advanced identification and authentication methods in military and defence applications, potentially revolutionising current practices.

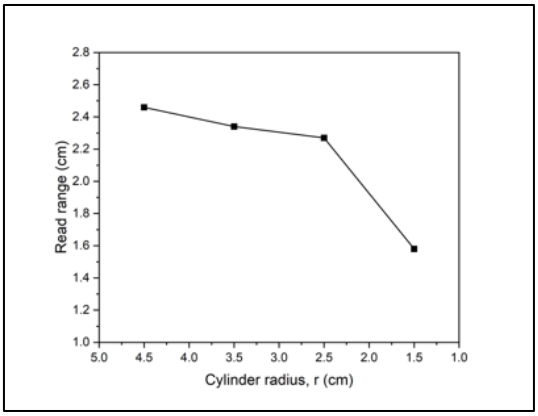

Figure 10: *Example of text data that can be written and read on the NFC tag using NFC Tools apps.*

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Contextualising the CBRE Threat for Brunei Darussalam

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Abstract

Introduction: With so little information to substantiate their existence, the Chemical, Biological, Radiological, and Explosive (CBRE) threat of Brunei Darussalam either poses a very low threat or none at all. This study aims to present the risk assessment of CBRE threat contextualising for Brunei Darussalam to see its relevance in considering CBRE as a threat to be concerned with.

Methodology: The 'Tier of Risk' method is used in this study. In order to consider all possible threats Brunei Darussalam may encounter, two decades of past incidents that happened throughout the world which are as considered as most relatable to Brunei Darussalam context were analysed. Tier 1 risk will be the most concerning threat as the likelihood for it to happen is high, and its impact will also be high. Meanwhile, threats allocated in Tier 2 either have a very high possibility of happening but give low implications or have a very low probability of occurring but will provide a very high impact if it is to happen. Tier 3 is the least concerning threat as the likelihood and impact of it happening are relatively low.

Results: The risk assessment of CBRE threat in the Brunei Darussalam context concluded that most possible risks fall into the Tier 2 level of risk and that the likelihood for them to happen is low but will have a significant impact if they occur.

Conclusion: Although no significant CBRE incidents have happened or are presently occuring in Brunei Darussalam, the threat should not be considered non-existent as the impact from it is massively devastating. The risk assessment may result in Tier 2, where the possibility for it to happen is unlikely, which does not point to such threats will not occur. With CBRE threats within the South Asian region growing and developing over time, the risk assessment could shift from Tier 2 to Tier 1.

1. Introduction

Chemical, Biological, Radiological, and Explosives (CBRE) in a conflict is nothing new as it goes back to the 14th century when the first Biological Warfare was suspected to be involved during the siege of Caffa in 1346 [1].

The use of CBRE elements continues to evolve, aligning with the modernisation of the world. At the beginning of the 21st century, the world was shaken by the term Improvised Explosive Device (IED) which became commonly used in the Iraq War in 2003 [2].

With the rise of Islamic Radicals activities, which started in the Middle East with the September 11 incident in 2001, the effects were fast to reach the South East Asia region, especially within Indonesia's largest Muslim population. The increase in the number of IEDs incidents in the area closer to Brunei Darussalam, such as the Bali Bombing in 2002, has made Brunei Darussalam recognise the need to develop its forces by establishing a Chemical, Biological, Radiological, and Explosive Defence Unit. Thus, in 2010, the Chemical, Biological, Radiological, and Explosive Defence Unit was established under the command of the Support Battalion, Royal Brunei Land Forces where the primary role of this unit is to protect and defend the sovereignty from the threats of Chemical, Biological and Radiological Warfare as well as from IED threats.

To date, Brunei Darussalam has no experience of serious incidents pertaining to CBRE threats which may have been contributed by a robust whole of government approach towards protecting and defending the sovereignty. However, with increased conflicts and threats worldwide, particularly within the South East Asia region, Brunei Darussalam should consider all possibilities.

Therefore, this study aims to present the risk assessment of the CBRE threat in Brunei using the Tier of risk method.

2. Methodology

Tier of Risks

The normed approach to risk assessment is based on the definition of probability and consequence, which is easier to be expressed in the Risk Map, as shown in **Figure 1**. The risks are then classified into four quadrants depending on the threats' probability and impact.

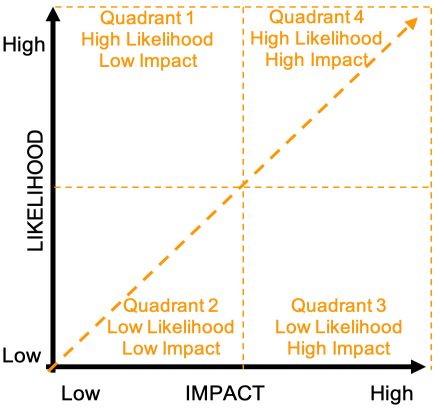

Figure 1: *Risk map.*

In this study, the risk assessment will be presented in tiers where Tier 1 is considered a threat with high risk and Tier 3 is considered a threat with low risk, as shown in **Figure 2**.

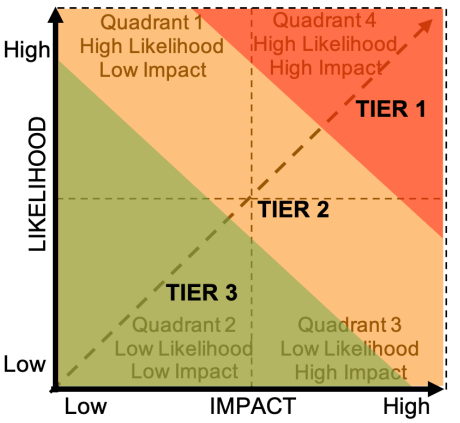

Figure 2: *Tier of Risks.*

In order to give a precise threat analysis, the risk assessments are divided into respective elements of Chemical, Biological, Radiological, and Improvised Explosive Devices.

Chemical Agent

Chemical Warfare threats are divided into Chemical Warfare Agents (CWA) and Toxic Industrial Chemicals (TIC). The NATO definition of a chemical agent is a chemical substance intended for military operations to kill, seriously injure, or incapacitate people because of its physiological effects [3]. Meanwhile, TIC is defined as any substance produced and used by industry for various purposes. Because of its chemical, physical, or biological properties, it poses a potential risk for life, health, the environment, or property when not properly contained [4].

Although Brunei Darussalam has never experienced any severe incidents related to chemical agents nor TIC, Brunei Darussalam is not potential-free from it to happen especially as a country that has the 9th largest Liquefied Natural Gas (LNG) reserve in the world as well as the 4th largest oil producer in the Southeast Asia region [5]. The major Key National Infrastructures (KNIs) of Brunei Darussalam that can potentially pose a chemical threat are shown in **Table 1**.

Apart from production industries, Brunei Darussalam also has chemical-bound industries in hazardous waste management companies, as shown in **Table 2**.

The KNIs, however, had a few incidents in the past where most of the cases were related to equipment failure or Health, Safety, and Environment related, as per **Table 3**.

In order to present the threat, an analysis is made of past incidents other countries have encountered. From the assessment, Brunei Darussalam is more prone to TIC threat than CWA and the possible threat of Chemical Agent in Brunei Darussalam had come to be as presented in **Table 4**.

Table 1: *Brunei Darussalam major KNIs.*

KNIs	Description
Hengyi Industries *Sendirian Berhad*	Located at *Pulau Muara Besar*, exports a total of 6.38 million tonnes of petroleum products and 1.7 million tonnes of petrochemical products in 2020.
Brunei Shell Petroleum	Located in Seria, produces approximately 127,000 barrels of oil per day and 243,000 barrels of oil equivalent to natural gas per day.
Brunei Methanol Company	Located in Sungai Liang, a methanol plant that has a daily capacity to produce up to 2,500 metric tonnes of methanol that are converted from natural gas.
Brunei Fertilizer Industry	Located in Sungai Liang, has a state-of-the-art facility that has a production capacity of 1,365,000MT of UREA per year.

Table 2: *Hazardous waste-management companies in Brunei Darussalam.*

Companies	Description
CIC Environmental Services *Sendirian Berhad* (CIC)	Incorporated company specializing in hydrocarbon and hazardous waste management services to the oil and gas industry in Brunei Darussalam.
Kehasan (B) *Sendirian Berhad* Integrated Environmental Services (KIES)	Primarily set up to run the Recovery Facility of Used Tyres at *Bukit Udal*, Tutong better known as *Bukit Udal* Material Recovery Centre.

Table 3: *Past incidents.*

Year	Headlines	Description
2012	*Shells Spills Oil in Brunei* [6]	The oil spill originated from a leak at Single Buoy Mooring.
2015	*Selangkir-2 Offshore Pipeline Leak* [7]	Situated at an unmanned platform, the leak was discovered using a gas detector.
2021	*Kuala Belait Dawn Fire Injures One* [8]	Fire broke out in the CIC Environmental Services Sdn Bhd building that involved Class 3 hazardous materials.
2021	*Two Hurt from Gas Explosion* [9]	Explosion caused by gas leakage from an LPG gas pipe.

Biological Threat

According to the Centres for Disease Control and Prevention (CDC), Biological Threat is an infectious disease with the potential to spread and cause an outbreak. Infectious diseases are illnesses caused by germs such as bacteria and viruses that require close contact between two people or can be spread by germs carried in the air, water, food or soil or by biting insects or animals. [18]

In a Biological Warfare context, the biological agents are classified into several main categories namely, Viruses, Bacteria, Fungi, Other Microorganisms and Toxins. [19] Generally in warfare, these agents may serve the following purposes [20]:

1. To cause illness
2. To cause death
3. To cause fear
4. To cause societal disruption
5. To cause economic damage
6. To disrupt the country's food supply

Table 4: *Chemical agent possible threats.*

Ser	Year	Incident	Involvement	Causes	Potential Risk to Brunei Darussalam	Risk No
(a)	(b)	(c)	(d)	(e)	(f)	(g)
1	2015	LPG leak on a pipeline in an LPG depot [10].	Liquefied Petroleum Gas (LPG)	Power failure of an inverter cause a shut down which lead to increased pressure in pipeline.	Gas Cloud from LPG pipe leakage.	C1
2	2016	Two dead in ammonia leak at Petronas Plant [11].	Fertilizers Plant	Pipeline failure due to poor regulatory check.	Ammonia Leak in Fertilizer Industry.	C2
3	2016	7 people suffer eye irritation, difficulty in breathing after chlorine leak off Tuas [12].	Storage Facility, Chlorine Gas	Leakage of one-tonne cylinder of Chlorine Gas in an indoor storage facility.	Chlorine Gas Leak	C3
4	2019	Hanwha Total's chemical leak affects 650 people in South Korea [13].	Petrochemic al Plant	Workers poor knowledge in operating the equipment	Chemical Gas Leak in Petrochemical Plant.	C4
5	2019	Two schools closed, 30 hospitalized after chemical waste illegally dumped in Pasir Gudang river [14].	Hazardous Waste	Illegal dumping of toxic chemicals into the river.	Illegal hazardous waste dumping.	C5
6	2019	Murder at the airport: the brazen attack on Kim Jong Name [15].	Nerve Agent (VX)	Direct contact of chemicals from hand and towel to face.	Illegal Import of Illicit Chemicals.	C6
7	2022	State of emergency over Thailand oil spill [16].	Oil and Gas	Failure on one of the subsea flexible hoses of Single Point Mooring.	Major Oil Spill.	C7
8	2022	125 die as tear gas triggers crush at Indonesia soccer match [17].	Tear Gas	The police decided to firing the tear gas after all preventive action has failed and fans began to attack the police, acting anarchically and burning vehicles.	Dispersion of Tear Gas	C8

For Brunei Darussalam, the country has never experienced or recorded any Biological Warfare Attacks.

Nonetheless, this country is not immune against any biological threats as historical data has shown that the Brunei population has experienced several cases that relate to biologically related cases primarily on the outbreak of epidemic and pandemic. **Table 5** shows several biological-related diseases with their Total Cases and Total Death that have been recorded in this country:

From **Table 5**, it can be seen that Total Death is rather low in almost all of the stated diseases with the exception of COVID-19, where the Total Cases and Total Death are rather high compared to other types of diseases.

As stated in **Table 6**, COVID-19 was brought into the country by a local male coming back from Kuala Lumpur. It was the starting point of a disastrous disease which caused security concerns in Brunei as food supplies including manpower were scarce as the whole country had undergone partial lockdown.

Table 5: *Diseases with total cases & deaths.*

Diseases	Year	Total Cases	Total Death
COVID-19	2022	169,496	46
H1N1 (Swine Flu)	2009	142	Nil
Japanese Encephalitis	2016	01	Nil
Dengue	2020	43	01
Chickenpox	2019	4,261	Nil
HFMD	2019	3,047	Nil
Gastroenteritis	2019	8,290	Nil

Table 6: *First reported cases in Brunei.*

Diseases	Cases
COVID-19	First imported case on 07 March 2020, when a local male came back into the country from Kuala Lumpur [21].
H1N1 (Swine Flu)	In May 2009, 9 year and 6-year-old students were the first confirmed cases of H1N1 in the country where both had returned from abroad [22].
Japanese Encephalitis	First reported in the county in 2013. It is one of the mosquito-borne diseases transmitted by the Culex mosquito [23.]

Table 7: *Biological agents possible threats.*

Ser	Year	Incident	Involvement	Causes	Potential Risk to Brunei Darussalam	Risk No
(a)	(b)	(c)	(d)	(e)	(f)	(g)
1	2009	First confirm cases of H1N1 (Swine Flu) in Brunei	H1N1 (Swine Flu)	A 9 year and 6 year old student just came back from abroad (London & Singapore) into the Country	Importing Other Infectious Diseases into the Country	B1
2	2020	First confirm cases of COVID-19 in Brunei	COVID-19	A local male just came back into the country from Kuala Lumpur	Importing Other Infectious Diseases into the Country	B2
3	2019	World Health Organization estimate, cases of Japanese Encephalitis globally each year, with approximately 13,600 to 20,400 deaths	Japanese Encephalitis	Japanese Encephalitis Virus (JEV) is transmitted to humans through bites from infected mosquitoes of the Culex species.	Spreading of Victor-Borne Diseases by the bite of infected insect	B3
4	1998 to 1999	National Library of Medicine – Outbreak of Nipah Virus in Peninsular Malaysia and Singapore	Zoonotic Virus	Infected fruit bats can spread virus to domestic animals (e.g., dogs, pigs, cats, goats, and horses) directly or indirectly, through food products contaminated by fruit bats	Spreading Zoonotic Virus	B4

Even though Brunei has never experienced any Biological Agent incident, it should not be dismissed entirely. A collective of past Biological Agent incidents from other countries are used in developing the Potential Biological Risk Assessment as shown in **Table 7**.

Radiological Agent

Radiological threats may appear in various forms. In conventional settling, nuclear weapons are perhaps of greatest concern. Definition of Radiological Agents are radioactive materials released that have adverse health effects where the release may be intentional or unintentional [24].

Despite the data showing that the stated diseases are manageable due to the country's excellent general health system, they should not be taken lightly as they can escalate into a more severe case such as a pandemic or epidemics. **Table 6** shows when and how such diseases came into the country. The most recent pandemic that struck the country was COVID-19. Among all the biological-related diseases, it was the highest infected case with the total number of deaths.

Radiological threats may occur in the form of warhead payloads and their accessories. Another radiological threat is Dirty Bomb, an improvised device using explosives to disseminate radiological material, causing localized contamination.

In the Brunei Darussalam context, as Radiological material is not readily available in the market nor is it accessible and permissible to possess, the main concern is more towards Radiological waste. Radiological waste is another radiological threat that has a significant concern to the country.

Irresponsible radioactive waste management has led to numerous accidental large-scale contaminations and falling into the hands of people or organizations with criminal intent. The Radiological Waste per se comes from equipment that contains Radioactive material for it to be operated.

The most widely used radioactive materials are cesium-137 and nickel-63. Cesium-137

Table 8: *Radiological agent possible threats.*

Ser	Year	Incident	Involvement	Radiation Level/ Content	Potential Risk to Brunei Darussalam	Risk No
(a)	(b)	(c)	(d)	(e)	(f)	(g)
1	2012	Radioactive tissue box holders yanked from Bed Bath and Beyond shelves [26].	Cobalt-60	Spending 30 minutes a day near the tissue box is equivalent to couple of chest x-rays	Radioactive materials contain in recycle scrap metal	R1
2	2018	Radioactive device goes missing in Malaysia [27].	Iridium-192	The 23kg (50lbs) large metal tube with a carrying handle contains the radioactive isotope iridium-192 which can cause radiation exposure or be used as a weapon if combined with a conventional explosive device.	Illegal possession of Radioactive Material from disposed equipment	R2
3	2020	Indonesia probes suspected nuclear waste dumping at housing estate [28].	Caesium-137	Radiation levels in the empty lot showed 680 millisieverts (mSv) per hour, about the same as the maximum level of radiation that workers responding to the Fukushima nuclear plant meltdown in Japan in 2011 were exposed to.	Illegal dispose of Radioactive Material on unrestricted area	R3

is commonly used in the medical sector and calibrating equipment used in the oil and gas industry. Meanwhile, nickel-63 is widely used in detectors to detect explosives, hazardous chemicals, and vapors.

Improvised Explosive Devices (IEDs)

The 2002 Bali bombings were Southeast Asia's earliest and most devastating terrorist attacks. Since the Jemaah Islamiyah (JI) linked suicide attacks, which killed around 202 people and injured 209 others, security authorities and various terrorist groups in Southeast Asia have evolved and upgraded their operational capabilities [29].

Those who create IEDs continuously change the device's characteristics and functioning or delivery method.

Brunei Darussalam has never encountered a Radiological Incident in the past or the present. The present national authorized body to control the use and disposal of radioactive material in Brunei Darussalam, the Safety, Health, and Environment National Authority (SHENA) plays a vital role in regulating workplace safety and health, environment, and radiation matters. However, the disposal of radioactive material is a concern as there is no disposal facility where the users must return the equipment to the country of origin [25]. This may be the main risk of concern in terms of Radiological Agents. Based on the analysis of past incidents other countries had encountered, the risk that has been assessed as possible for Brunei Darussalam is presented in **Table 8**.

United Nations defines IED as a device placed or fabricated in an improvised manner incorporating explosive material, destructive, lethal, noxious, incendiary, pyrotechnic materials or chemicals designed to destroy, disfigure, distract, or harass, which may include military stores but are normally devised from non-military components [30]. It generally consists of a switch, power source, initiator, container, and explosives. All IEDs can be classified as either timed, command, or victim-operated. Therefore, the safe conduct of IEDs disposal relies upon appropriately trained and qualified IEDD operators having a thorough knowledge in this area and of the increasing complexity of these devices. IEDs are most frequent in the Southeast Asia militant landscape, which always relates to terrorists.

They were frequently used against Westerners before the emergence of the Islamic State (IS) and the attacks sought to drive out "Western influence" from Muslim nations, including Indonesia. **Table 9** demonstrates that most IED attacks in the area have taken place in tourist hotspots or locations with Western diplomatic representation.

Table 9: *IEDs attack targets.*

Year	Incidents	Country	Target
2000	Rizal Day Bombing	Philippines	Diplomats, Tourist
2002	Bali Bombing	Indonesia	Tourists
2003	Jakarta Bombings	Indonesia	Tourists
2004	SuperFerry 14 Bombing	Philippines	Tourists
2004	Australian Embassy Bombing	Indonesia	Diplomats
2005	Bali Bombings	Indonesia	Tourists

Although Brunei Darussalam has never experienced any incidents related to IEDs, the rise in their usage and impact, particularly on civilians, and its unlawful use has led to deaths and terror among civilians, is of great concern. Brunei Darussalam believes that a whole-of-nation approach must be undertaken to counter such threats. Similar to the effort in counter-terrorism, coordination of multi-government agencies ranging from the

military, police force, and immigration as part of the counter-Improvised Explosive Devices (c-IEDs) measures.

Despite the solid Whole-of-Nation approach, Brunei Darussalam was not excluded from becoming terrorists' location of interest as their safe haven, especially during the rise of the so-called Islamic Caliphate in the Middle East. The past incidents on terrorism in Brunei Darussalam are shown in T**able 10**.

Looking at the past incidents, no IED-related incident was recorded in Brunei Darussalam. If the incidents were not dealt with in decisive action, it could have contributed to making IEDs in Brunei Darussalam, especially that IEDs are conveniently made using commercial sources. Hence, the risk that has been assessed as possible for Brunei Darussalam is presented in **Table 11**.

Table 10: *Brunei's report on terrorism-related incidents.*

Year	Headlines	Description
2014	Brunei detains Indonesian on terror suspicions [31]	A member of JI suspected of plotting to help militants enter and use tiny Brunei as a Safe Haven and to channel financing to militants abroad.
2015	Brunei ISD Imposed Restriction Order on Terrorist Assistant [32]	A 34-year-old local woman linked with a foreigner who had planned to join a terrorist organization where she facilitated his entry into the country and planned to get married.
2016	More than 50 terror suspects arrested during the Hajj [33]	The terror suspects included one Brunei citizen which was being investigated to verify his involvement in terror operations that took place in the Kingdom.
2017	4 Indonesian deported for IS terror links in Brunei [34]	All four were deported and blacklisted from re-entering Brunei due to their predisposition towards the ideology of IS.
2018	Local man detained for alleged links to ISIS [35]	The suspect provided financial contributions and also planned to move his family over to Syria.

3. Results

Figure 3 shows the result from the threat analysis for CBRE's possible risk that has been determined through various past incidents.

The risk assessment of CBRE threat in the Brunei Darussalam context concluded that most possible risks fall into **Tier 2** level of risk that the **likelihood** for them to happen is **low** but will have a **significant impact** if they happen.

The most concerning element among the CBRE is the Radiation aspect as it will give a prolonged effect not just on physical human beings, but also on the environment.

4. Discussion

Despite the risk assessment resulting in Tier 2, where the possibility for it to happen is unlikely, it does not mean such threats will not occur. Brunei Darussalam, as an individual country, with a robust security approach through the whole of government cooperation, may be able to suppress any possible threats in an appropriate course of action.

However, the growing threats within the region raised the likelihood for it to happen in this country, the same reason the Defence White Paper outlining the need to evolve our force capabilities, especially the threats are now supplementary towards non-traditional settings. The increase in cases pertaining to Chemical, Biological, Radiological, and Improvised Explosives be it warfare or industrial incidents within the South Asian region is very concerning and there is a solid perception of the shift of power from West to East where this could generate South Asia as the next theatre of conflict.

Hence, conceding that the existence of CBRE threats within the South Asian region is concerningly growing and developing over time, the risk assessment could shift from Tier 2 to Tier 1.

5. Conclusion

Although no significant incidents on CBRE have happened or are presently occuring in Brunei Darussalam, the threat should not be considered non-existence as the impact from it is massively devastating. Although, Brunei Darussalam is regarded as a nation that has a solid approach in terms of defending its sovereignty from any possible threats, consideration should always be taken over growing threats within the region as any gap could lead to infiltration of risk.

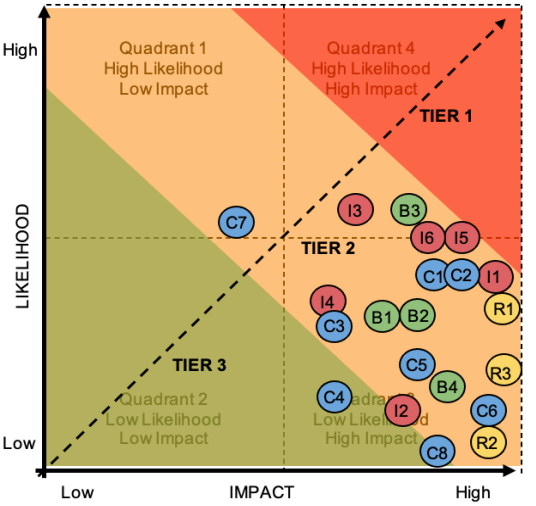

Figure 3: *Brunei Darussalam's CBRE Threat Tier of Risk.*

Table 11: *IED possible threats.*

Ser	Year	Incident	Involvement	Causes	Potential Risk to Brunei Darussalam	Risk No
(a)	(b)	(c)	(d)	(e)	(f)	(g)
1	2004	Thai bomb theft sparks terror fears [36].	Ammonium Nitrate	Ten armed men raided a quarry in the southern province of Yala, stealing more than 1,300 kilograms of ammonium nitrate, the main explosive used in the Bali bombings.	Fertilizer theft for Bomb Making	I1
2	2014	Malaysia arrests suspected Islamic State Militant Recruits amid fears of rising extremist support [37].	Extremist Ideology	A group of 19 suspected Islamic militants plan to join the Islamic State in Syria, as well as carry out bombings on a brewery and bars in the outskirts of Kuala Lumpur.	Terrorist Recruitments	I2
3	2016	*Polis marin tahan dua lelaki, rampas pelbagai barang dipercayai buat bom ikan* [38].	Ammonium Nitrate, Detonator, Sodium Cyanide	Also arrested as a second suspect is a 22-year-old Brunei citizen.	Fish Bomb Practice	I3
4	2016	Local Man Nabbed for Bomb Scare [39].	Bomb Hoax	A phone called was made claiming that a bomb had been planted at the building.	Bomb Scare	I4
5	2020	Probation for youth who detonated homemade bombs at East Coast Park [40].	Pipe Bomb, Black Powder	The youth started researching how to make bombs online during the COVID-19 period and had bought 200 boxes of matchsticks to make pipe bombs.	Pipe Bomb making from Black Powder	I5
6	2022	Malaysian police believe jealousy could be motive behind bomb attack that killed restaurant waiter [41].	IED	Among materials found were power bank devices, paper cutters and batteries. Police believe the know-how to build bomb was gleaned from social media.	E-learner IED	I6

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Near Vertical Incidence Skywave (NVIS) High Frequency (HF) Portable Antenna

Authors: *Muhammad Rawie bin Bungsu, and Mohd Fazlee bin Umarzuki*

Abstract

This report is about Near Vertical Incidence Skywave (NVIS) High Frequency (HF) Portable Antenna which is chosen for Land Engineering Work Improvement Teams (LE WITs). Explanation about NVIS from how it works, its difference with traditional Skywave propagation and its relation with ionosphere. Additionally, the report provides explanation regarding what problem it will solve from the current used antenna, along with its feature and the whole process from building to testing the NVIS HF Portable Antenna and challenges encountered.

1. Introduction

Near Vertical Incidence Skywave (NVIS) is a propagation mode in which signals are transmitted using high angle radiation almost vertical and returned back to Earth from the ionosphere almost vertically in order to provide local or regional coverage. Compared to traditional Skywave, it has low angle radiation while NVIS have high angle radiation (as shown in **Figure 1**). NVIS is often used in environments that are challenging for traditional High Frequency (HF) propagation modes, such as mountainous regions. The military has used NVIS techniques for decades to provide short haul communication with other units on the ground. The selected title for this project is HF portable NVIS antenna.

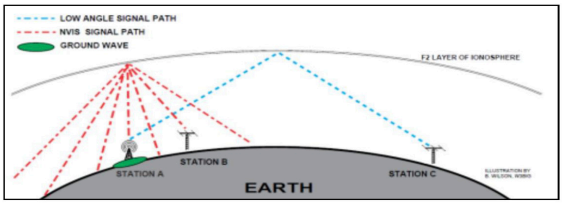

Figure 1: *NVIS & traditional Skywave signal path.*

Figure 2: *HF Horizontal Dipole Antenna.*

2. Problem statement

The NVIS can contribute and assist the military during the deployment of HF radio. It is found out that during the military deployment of HF radio, they usually use horizontal dipole antenna (as shown in **Figure 2**). The problem with using dipole antenna is that the antenna needs to be facing the location of the other station to establish communication. The second problem is that it uses traditional skywave propagation, thus prone to skip zone. Horizontal dipole antenna can also be adjusted to utilises NVIS propagation mode by lowering the height of the antenna, but the positioning of the antenna must be facing the other station since it is a bi-directional antenna. The selected antenna made for this project is an omni-directional antenna, thus the positioning of the antenna would no longer be an issue as it can still establish communications at all directions.

3. Skywave propagation

There are three different types of radio propagation, which are Line of Sight (LoS), Ground wave and Skywave propagation. For HF Portable NVIS antenna, the type of propagation used is Skywave propagation. Skywave propagation is the propagation of radio waves reflected or refracted back toward Earth from the ionosphere, an electrically charged layer of the upper atmosphere. Since it is not limited by the curvature of the Earth, skywave propagation can be used to communicate beyond the horizon, at intercontinental distances.

4. Ionosphere related with skywave

As mentioned before, NVIS antenna is where signals are transmitted with the radiation angle almost vertical to the Ionosphere and reflected back to Earth. The Ionosphere contains three different layers that are:

- D Layer,
- E Layer and
- F Layer.

D-Layer. D-Layer is the first region in the ionosphere that sky wave will reach when it leaves the Earth's surface and travels upwards. It is present at the altitudes approximately from 60 to 90 kilometers. The D-layer only exists during daytime and disappears at night time. D-layer mainly acts as an absorber of HF signals. The lower the frequency signal, the more that signal is attenuated by Dlayer absorption. Thus, the higher the frequency of a signal, the less of the signal became attenuated. The D-layer absorption also increases with increasing ionisation; thus, absorption is usually highest at midday when solar radiation is highest. Because of D-layer absorption, higher frequency HF skywave signals propagate better during the daytime, whereas lower frequency signals propagate better at night time due to the disappearance of the D-layer.

E Layer. The E-layer is above the D-layer. It exists at altitudes approximately from 100 to 125 kilometers. Unlike the D-layer, this layer has the ability to refract HF signals back towards the Earth; However, this layer still acts as an attenuator to a certain degree. Compared to the other layers of the ionosphere, the E-layer is relatively thin, usually approximately 10 - 25 km. Like the D-layer, the E-layer is much more ionised, during the day, but unlike the D-layer, it does not completely disappear at night. As the frequency increases, it is found that the amount of refraction decreases until it reaches the threshold frequency where the signals will no longer be refracted and will pass through the region and move on to the next layer above it.

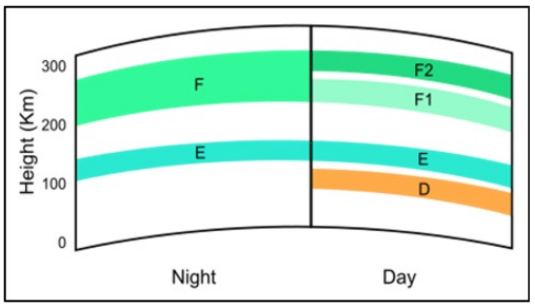

Figure 3: *Ionospheric layer during night & day.*

F Layer. The F-layer is the most important ionospheric layer for HF skywave propagation. During the daytime, the F-layer splits into two sub-layers that are F1 and F2. The first sub-layer, F1 is found at altitudes greater than 160 km to 220 km. The second sub-layer, F2 is found at altitudes greater than 250 km to 400 km. During the night, these two sub-layers will merge back into one layer, Flayer. Compared to the D and E layers, the height of the F-layer(s) changes considerably based on various factors such as time of day, season, and solar conditions. The lower F1-layer primarily supports short- to medium-distance communications during daylight hours. The F2-layer, on the other hand, is present more or less around the clock. The F2-layer has the highest altitude and the highest ionization of all the layers and therefore it is responsible for the vast majority of long distance skywave communications at HF.

5. NVIS HF portable antenna

There are many different types of NVIS antenna but for this project, the selected antenna is Inverted V antenna, which consists of two crossed inverted V dipoles positioned at right anglesto each other and is supported at the center by a 15-foot mast (shown in **Figure 4**). One of the main advantages of an NVIS inverted V antenna over a standard horizontal dipole is that this type of antenna is easy to setup. It has only one central support and therefore can be raised by a single person.

Even though NVIS antenna has a lesser range than traditional skywave propagation, but because of the size of Brunei Darussalam, NVIS antenna is good enough to cover the whole Brunei Darussalam. NVIS antenna can establish reliable communication up to 350 km. The farthest distance of Brunei Darussalam is only around 140 km (as shown in **Figure 5**).

Figure 4: *NVIS Inverted V Antenna.*

Figure 5: *Google Earth Image of Brunei Darussalam.*

6. NVIS features

There are many features for NVIS antenna, the features are:

• NVIS covers the area which are normally in the skip zone of a traditional skywave propagation. A skip zone is referred as the area located outside of ground waves but before the first skywave returns to earth. It is a region where radio transmission cannot be received (as shown in **Figure 6**).

• NVIS does not require additional infrastructure such as repeaters or satellites. Two stations employing NVIS technique is enough to establish reliable communications without the support of any third party.

• Antennas optimised for NVIS are usually low. A proper NVIS antenna can be set up easily by a small team or just one person in a short amount of time while also making them discreet and difficult to notice.

• Low areas and valleys are not a problem for NVIS propagation as obstructions are much less important to NVIS compared to traditional skywave.

• The shorter overall path length reduces the attenuation between transmitter and receiver.

• NVIS also works well at relatively low transmit power levels.

• Permits a great deal of flexibility in the set-up of NVIS antenna due to the antenna is an Omni-directional antenna.

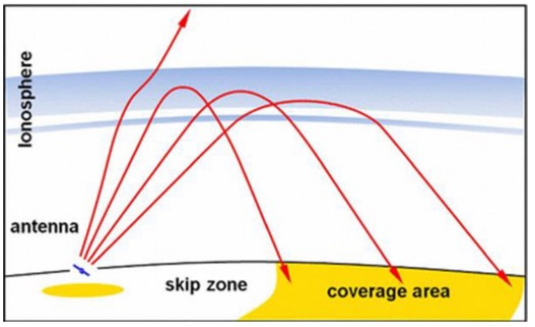

Figure 6: *Skip Zone.*

7. Items for Building Antenna

The items needed to build this antenna is listed in the **Table 1** below. The total cost for the items needed is BND$161.60. The instructions to build the antenna is shown in **Attachment 1**.

Table 1: *List of items and costs.*

No.	Items	Unit	Qty	Price
1	1 1/2" PVC Pipe	ft	15	$20.00
2	1 1/2" PVC Male Connector	Each	2	$3.00
3	1 1/2" PVC Female Connector	Each	2	$4.00
4	1 1/2" PVC cap	Each	2	$3.00
5	UHF Female Connector	Each	1	$5.00
6	UHF Male Connector to RG58	Each	1	$5.00
7	BNC male connector to RG58	Each	1	$4.00
8	Heat Shrink	Small box	1	$5.00
9	Electrical Wiring 1.5mm	m	40	$12.80
10	Ceramic insulator	Each	4	$6.00
11	Nylon rope 2mm	m	20	$2.50
12	RG58 coax cable	m	10	$30.00
13	Silicone	Each	1	$6.80
14	Army green color spray	Can(s)	2	$7.80
15	PVC Glue	Each	1	$2.50
16	Velcro strap	roll	1	$2.80
17	Nut & Bolt	Each	5	$4.80
18	¾" Tee Pipe	Each	16	$9.60
19	¾" PVC Pipe	ft	10	$7.50
20	Ground stake	Each	4	$7.90
21	Sandpaper 400	Each	1	$0.50
22	Terminal Connector	Each	4	$3.00
23	Black color spray	can	1	$3.80

8. NVIS antenna deployment

Due to the characteristics of the ionosphere and the take-off angle of the antenna, the optimal frequency range are from 2 MHz to 15 MHz. During day time, the frequency are from 4 MHz to 15 MHz, while at night time it is from 2 Mhz to 4 Mhz. Two NVIS Inverted V antennas were made to test the communication between two stations. The instruction to setup the antennas is shown in Attachment 2. There were three deployments that was done for the testing. The radio used for this deployment is HF Manpack, HARRIS RF5800H-MP (as shown in **Figure 7**).

For the first deployment, the two stations were located in Berakas Camp. Station one at Signal Squadron, while another station at open area near the Saddle Club with a distance of 1.9 km from each other (as shown in ***Figure 8***). For this deployment, two communication tests were conducted. First test used the Whip antenna to Whip antenna for both stations. Communication was able to be established. For the second test, station one used NVIS Inverted V Antenna while station two used Whip antenna. The main goal for this deployment was to check whether Whip antenna is able to receive the communication signal from station one. Unfortunately, communication was unable to be established and it might be due to station two not using NVIS antenna.

For the second deployment, the location was the same as the first deployment but this time both stations were using NVIS Inverted V antenna. However, the communication was still not successful. The reason might be due to the inadequate range.

For the third deployment, the location for station one was at Berakas Camp Saddle Club while station two at Muara, Jalan Serai Pimping where they are 10.8 km apart from each other (as shown in **Figure 9**). Two communication tests were conducted. The first test was using Whip antenna to Whip antenna for both stations. There was no communication signal received. For the second test, both stations were using NVIS Inverted V antenna. Communication was able to be established

Figure 7: *HARRIS RF5800H-MP.*

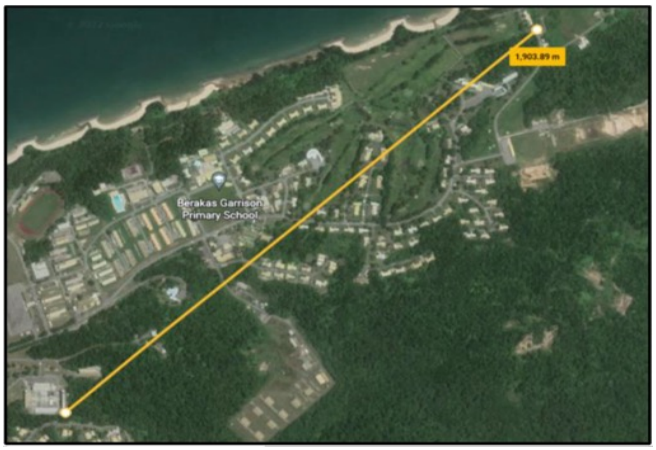

Figure 8: *Deployment 1 & 2 locations.*

Figure 9: *Deployment 3 location.*

9. Challenges

There are many challenges encountered during this project. First challenge would be the lack of experience as this is the first time building an antenna. Hence, it is difficult and took a long time to locate the items needed. Even then, when building the antenna, there were items that had been missed out, thus the project was delayed until the necessary items were acquired. This caused the building of the antenna longer than anticipated.

Second challenge would be in terms of availability. When setting schedules for building and testing antenna, the availability of team members, SWS Troops military personnel, vehicle and weather condition are also needed to be considered especially during the deployment of the NVIS antenna for communication test.

The third challenge would be finding suitable locations for the deployment of NVIS antenna. The area needs to be safe and wide enough to set up the antenna. The terrain needs to be soil since the antenna was designed to be used with ground stakes to hold the guy and the base of the antenna.

10. Future improvement

There are some things that needs to be improved for the HF portable NVIS Antenna. The first thing that needs to be improved is the material of the antenna mast. The material needs to be changed into something ler. For the antenna mast, the material can

be replaced into using a lighter white PVC pipe instead of heavier grey PVC pipe. The second one would be substituting the PVC spool of the antenna guy into a thin plastic board. The third would be creating a bag for ease of storing and portability. Lastly, improving the current antenna base which is PVC pipe cap attached with nut and bolt as spike, by changing it into a thin metal plate or plastic board to hold it firm to the ground, so that it is easier to set up the antenna.

11. Conclusion

In conclusion, the NVIS HF portable antenna created for this project utilises the NVIS propagation method where the signal is transmitted at a high angle radiation to the ionosphere and refracted back to the Earth almost vertically. The major feature of this NVIS antenna is that it can be easily set up by a small team or one person. Thus, reducing the personnel needed to set up and allowing other personnel to be assigned to another task. The second major feature is that it reduces the skip zone area of traditional skywave propagation. Since Brunei Darussalam is a small country, a large part of the area will be a skip zone of traditional skywave propagation where HF communication will not function. With an NVIS antenna, most of that area will be covered but it will also reduce the coverage range compared to traditional skywave propagation. Even though the coverage range is lesser than traditional skywave propagation, the coverage is more than enough to cover from end to end of Brunei Darussalam. Lastly, the antenna is an Omni-directional antenna and obstruction will be a less important factor. Because of this, the antenna can be set up at any orientation that is convenient at the particular radio site without regard to the location of other stations. Thus, it is believed that this antenna would aid in military HF radio deployment. The testing of the HF NVIS Portable Antenna was sucessful as commnications were able to be made from one station to another.

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Attachment 1: *Steps to build HF Portable NVIS Antenna*

A. Prepare the mast

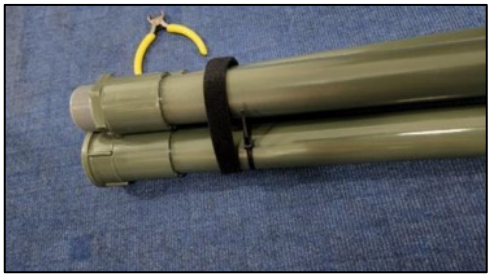
1. Sand PVC pipe and connector using sand paper

2. Glue using PVC glue and connect PVC connector.

3. Spray the PVC pipes and wait until dry.

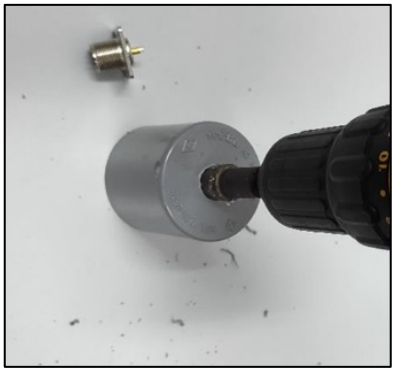
4. Attach adhesive Velcro band to each and every PVC pipe at the top and bottom areas of the PVC pipe.

5. Arrange and attach the PVC pipe with each other using Velcro tape



B. Prepare antenna

1. Drill a hole at top of the PVC cap to fit in the UHF connector.

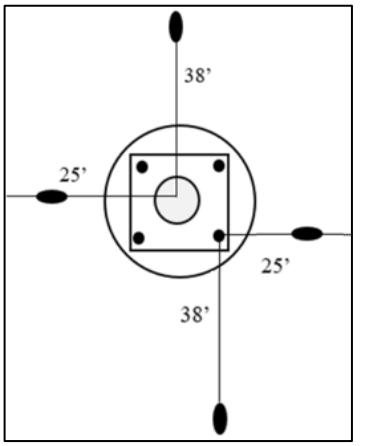


2. Drill hole for screw and then screw the UHF connector to hold it to the PVC cap.

3. Prepare electrical wire according to the lengths listed below:
   a. 25ft = 2 Qty
   b. 38ft = 2 Qty

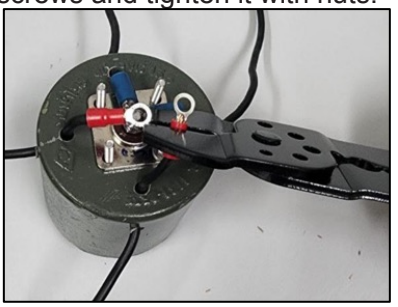
4. Strip the sleeves at end of the electrical wires and crimp to eyelets.

5. Arrange the electrical wire according the diagram below.



6. Solder the eyelets to nthe ozzle of the coax UHF connector.

7. Screw all four holes of the UHF connector and insert one eyelet for 25ft and 38ft to one of the screws and tighten it with nuts.

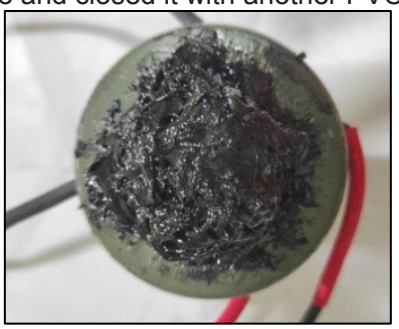


8. Prepare nylon rope according to the lengths listed below:
   a. 7ft = 2 Qty
   b. 20ft = 2 Qty

9. Attach the other end of each electrical wires and nylon ropes to the four insulators.

10. Make a loop at the other end for ground stakes.

11. Cover the top of the UHF Connectorwith silicone and closed it with another PVC Cap.



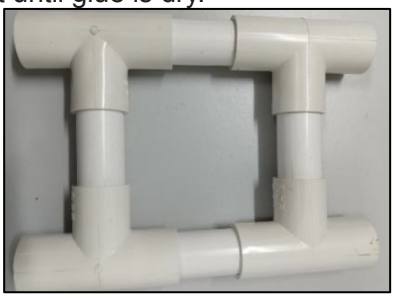
C. Prepare spool

1. Prepare 4 pieces of ½" PVC pipe 3 cm long and sandpaper it.

2. Prepare 4 pieces of ¾" Tee pipe.

3. Glue both ends of the ½" PVC pipe and interconnect it with ¾" Tee pipe.

4. Wait until glue is dry.

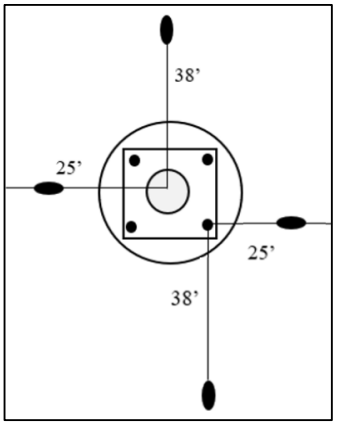


5. Sand the PVC spool using sand paper and spray and wait until dry.

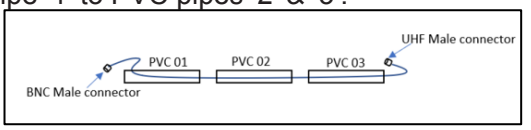
Attachment 2: *Setup procedure NVIS Inverted V Antenna*

1. Prepare and place all items needed.

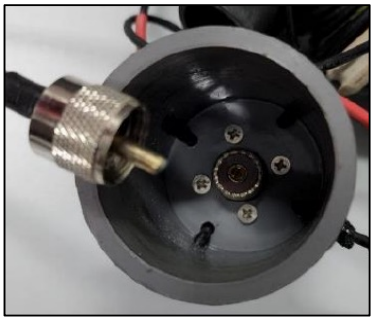
2. Arrange the antenna guy according to the diagram below.



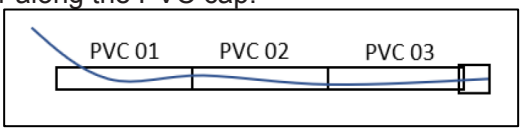
3. Insert coaxial cable and attach from PVC pipe '1' to PVC pipes '2' & '3'.



4. Connect coaxial cable with UHF connector male to UHF connector female at the PVC cap.



5. Connect all 3 PVC pipes '1', '2' & '3' together along the PVC cap.



6. Raise the antenna mast until the base is vertical to the ground.

7. Use ground stake to hold the end of antenna guy wire to the ground.

8. Connect the BNC male connector to the radio.

9. Ready to use for HF communication using certain range of frequency range (Day: 4MHz – 15MHz, Night: 2MHz - 4Mhz).

Technical Specification

Frequency Range	2 – 15 MHz
Application	HF Sky wave Communication
Impedance	50 Ω
Polarization	Horizontal / Vertical
Pattern	Omni - Directional
Connector	UHF Male & Female Connector
	BNC Male Connector
Mast Height	15 ft
Radiator (electric wire) length	38 ft x 2
	25 ft x 2
Insulator Rope length	**7** ft x 2
	20 ft x 2
Antenna Guy Wire	45 ft x 4
Color	Army Green
Weight (Kg)	7.50

About the Author

Nadzirah binti Haji Ibrahim is an Assistant Engineer Level III at the MERG Section at the Bolkiah Workshop, Land Engineering, RBLF. She has served for 8 years since 8th December 2014. She graduated with a Highest National Diploma (HND) in Computer and Communication Systems. Her work scope involves repairing various electronic equipment, communication RACAL radio module, harness ancillaries, Falcon III Intercomms RF7800I and commercial equipment. She has proven to possess the ability to produce good work and is always neat and accurate. She also demonstrates excellent skills and obeys the rules or discipline while on duty.

Portable Compact Intercom Simulator

Author: *Nadzirah Haji Ibrahim*

Abstract

A portable compact intercom simulator is designed for maintenance or fault finding of the RF-7800I Digital Intercom System. With numerous compact cables equiped in military veicles, it is very difficult to identify faults. With this simlutalor, the job is made easier because of its portability and the efficient placement of intercom devices and cables are placed such that they are removable and organised in their respective compartments. Other than that, this simulator is capable of voice communications through speech recognition and noise elimination, its software is configurable and upgradable in the field and supports up to four radio transceivers simultaneously with retransmission capability. The outcome from this project can create a positive impact in helping both military and civilian in all aspects, such as conducting courses, training and operational missions more effective and efficient. Nonetheless, this project can be further improved by adding batteries for its power supply, as well as making it more more compact by using a smaller and lighter tough box.

1.General descriptions

1.1. Introduction

Portable compact intercom simulator is a tough box that is specially designed for RF-7800I Digital Intercom System. It consists of a modular and configurable voice and data vehicular communication system which provides voice and data interoperability and connectivity among vehicle crew stations while simultaneously providing control of all vehicular communications. It is also compactly designed prior to dimensions of the Digital Intercom System, which consists of Central Unit, Crew Stations (Keypad Display Unit, Rotary Dial and Basic Unit), speaker, headsets and power disconnector. This simulator also has the ability to operate with Harris Falcon II and III radios as well as other military, government and commercial devices. Radio connectivity allows crew stations to communicate with dismounted personnel and other vehicles or command centers through HF, VHF, UHF, and Broadband Global Area Network (BGAN) satellite communications technology.

This portable compact intercom simulator supports RF-7800I systems that are built around a Central Unit (CU), which is connected to a customised combination of Crew Stations and additional components distributed throughout a vehicular configuration. The Central Unit in this simulator is pre-programmed prior to deployment / installation to specific mission parameters using the RF-7800I Digital Intercom System Control Center (DCC) software. The Cental Unit can be reprogrammed using the DCC as per required.

1.2. Objectives

- To design and build compact transportable of RF-7800I intercom simulator.
- To support RF-7800I Vehicular Intercom System compactly and portable in a specially designed tough box so that it can be easily carried to the site during maintenance or fault finding of intercom system in army vehicles.
- To ensure compatibility for army training course.
- To make the cables more organised and tidy.

1.3. Features

The portable compact intercom simulator has the following features:

- Intercom systems customised per vehicle configuration and mission requirements.
- Compact and transportable
- Voice communications through speech recognition and noise elimination
- Software confugurable and upgradable in the field.
- Supports up to four radio transceivers simultaneously with retransmission capability
- Small size and weight with minimal power cosumption.

1.4. Configurations

The RF-7800I Vehicular Intercom System provides vehicular voice and voice/data communications. The number of possible vehicular configurations in Portable Compact Intercomm Simulator is extensive and is mission defined.

- RF-7800I-CU100 Central Unit configuration
- RF-7800I-KD400 Keypad Display Unit 1-headset, 1-RS-232 configuration
- RF-7800I-RD200 Rotary Dial Unit 2-headset configuration
- RF-7800I-BU200 Basic Unit 2-headset configuration
- RF-7800I-SA100 Speaker Unit configuration

2. Power requirements

Power requirements will vary depending upon configuration. RF-7800I Central Units require minimal power to operate from vehicular battery/alternator DC power sources.

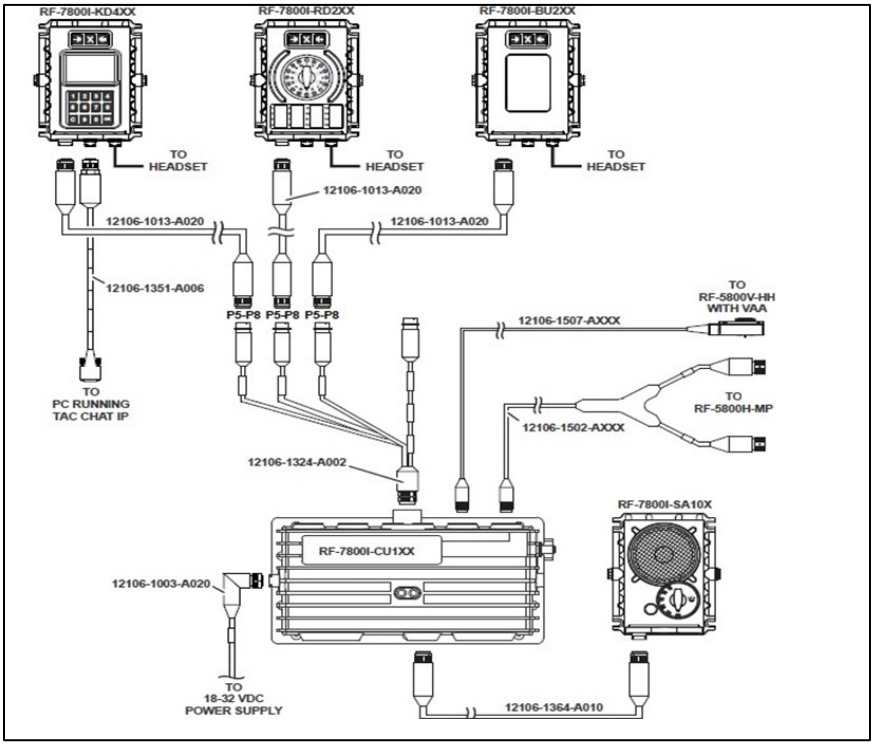


Figure 1: *Intercom voice and data diagram.*

The RF-7800I operates from a DC power source source between 18 and 32 VDC nominal. When used in a vehicle with a 12 VDC power system, a 12 to 24 VDC converter should be used. The addition of speakers, Crew Station units, and headsets will increase the power consumption.

2.1. Vehicular grounding

Inadequate grounding will degrade system operation and performance. When using any radio, RF voltages may be present on the chassis. These voltages could cause faults or equipment damage and present a serious personnel hazard due to RF burns or shocks.

Vehicle chassis ground straps should be as short as possible, ideally less than 12 inches (30 cm). Paint, grease, rust, etc. must be scraped away so that only bare metal is visible at grounding points. The cassis is used to frame or a welded steel body panel for the grounding point. Grounding is never coducted on trimmedor hinged panels (door, hood, or to surfaces which can be removed from the chasis such as dashboard or seats. Ground straps should be fabricated from tinned, braided copper of the correct length. For better grounding of any radio that connects to the RF-7800I, a wider ground strap is preffered. Position the ground strap so the action of the shock mount is not inhibited.

3. RF-7800I Vehicular Intercom System

This Portable Compact Intercom Simulator supports RF-7800I Vehicular Intercom System that consists:

- RF-7800I-CU100 Central Unit configuration

• RF-7800I-KD400 Keypad Display Unit 1-headset, 1-RS-232 configuration

• RF-7800I-RD200 Rotary Dial Unit 2-headset configuration

• RF-7800I-BU200 Basic Unit 2-headset configuration

• RF-7800I-SA100 Speaker Unit configuration

• RF-5051-PS001 HARRIS Power Supply

• Power Disconnect HARRIS/RF Communication

3.1. RF-7800I-CU100 Central Unit

The main component of the RF-7800I Vehicular Intercom System is the Central Unit (CU). The Central Unit performs voice channel switching and digital data packet routing between up to eight Crew Stations and additional component, while also providing control up to four radio transceivers. The Central Unit also monitors vehicle system status, station controls and indicators.

The RF-7800I system uses a 2-wire communications interface. Cable connections to the Crew Stations have four wires in total.Two wires are for Integrated Services Digital Network (ISDN) lines which provide control and power to the Crew Stations. The other two wires provide power for Active Noise Reduction (ANR) headsets. However, the RF-7800I system only requires two wires to function.

3.1.1. RF-7800I-CU Specifications

Table 1 provides specifications for the RF-7800I-CU.

Table 1: *Specifications for the RF-7800I-CU.*

Function	Specification
GENERAL	
Power Input Voltage Range	18-32 VDC nominal
Maximum Current Efficiency	300 Ma (+ each connected unit) does not include headsets
ENVIRONMENTAL	
Storage Temperature Range	-50 °C (-58 °F to + 149 °F) MIL-STD 810G
MECHANICAL	
Dimensions	25.60 L x 15.29 W x 8.46 H cm (10.07 L x 6.01 W x 3.33 H inches)
Weight	2.18kg (4.8 lbs) Standard and 1.73 kg (3.8 lbs) Light (both without cables)

3.1.2. RF-7800I-CU Central Unit Standard

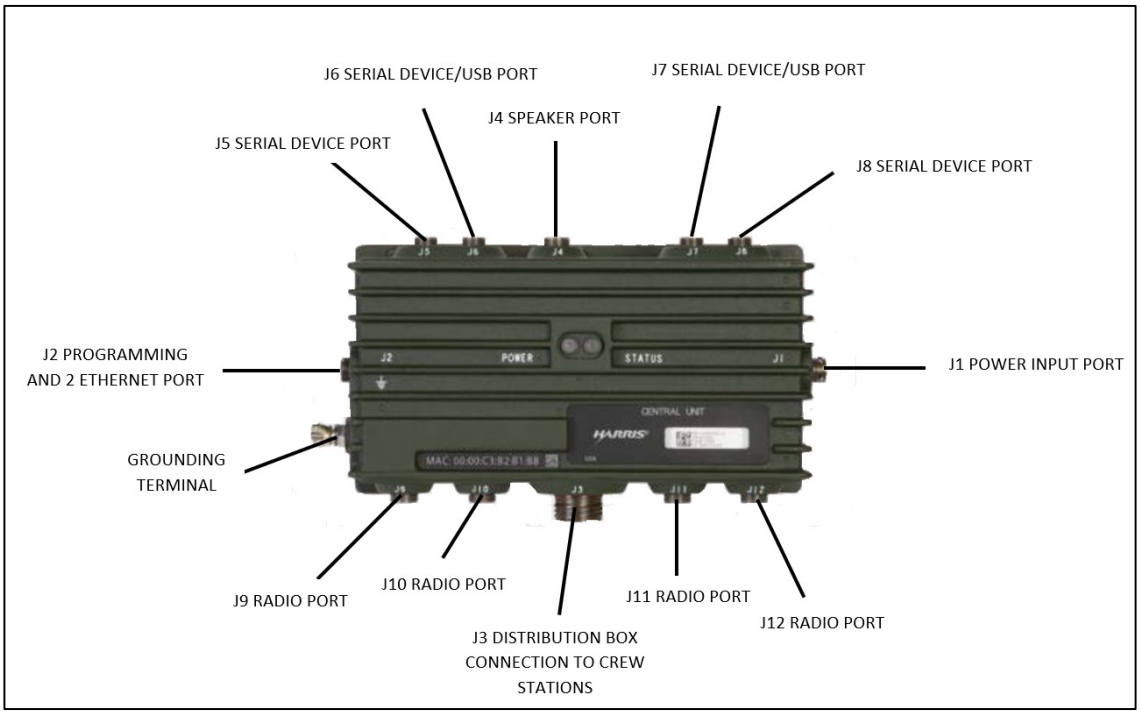


Figure 2: *RF-7800I-CU Central Unit Standard.*

3.2 Vehicular Intercom Crew Stations

The RF-7800I Central Unit interfaces to a variety of Crew Station types to provide customized vehicular communications for a wide range of applications. The three main types of Crew Stations, each with distinct user-interface capabilities and features, include:

- RF-7800I Keypad Display (KD) Unit
- RF-7800I Rotary Dial (RD) Unit
- RF-7800I Basic (BU) Unit
- RF-7800I Basic (BU) Unit

Crew Stations allow operators to monitor selected channels, conference with selected intercom users, monitor and transmit via radio transceivers. All Crew Stations provide voice communications using digital signal processing and background noise elimination. Crew Stations have a three button interface:

• Center (Red) button is a multipurpose button
  o Notify the user of Alarms and broadcasts
  o Change the setting menu options configured for the crew station

3.2.1 RF-7800I Keypad Display (KD) Unit

The most advanced Crew Station, the RF-7800I-KD Keypad Display Unit, provides operators with real-time command and control of the intercom's communication modes. The Keypad Display Unit combines voice station functionality with an icon driven keypad interface, allowing the input of numeric information and control codes while displaying options, messages and commands on the Organic Light-Emitting Diode (OLED) screen.

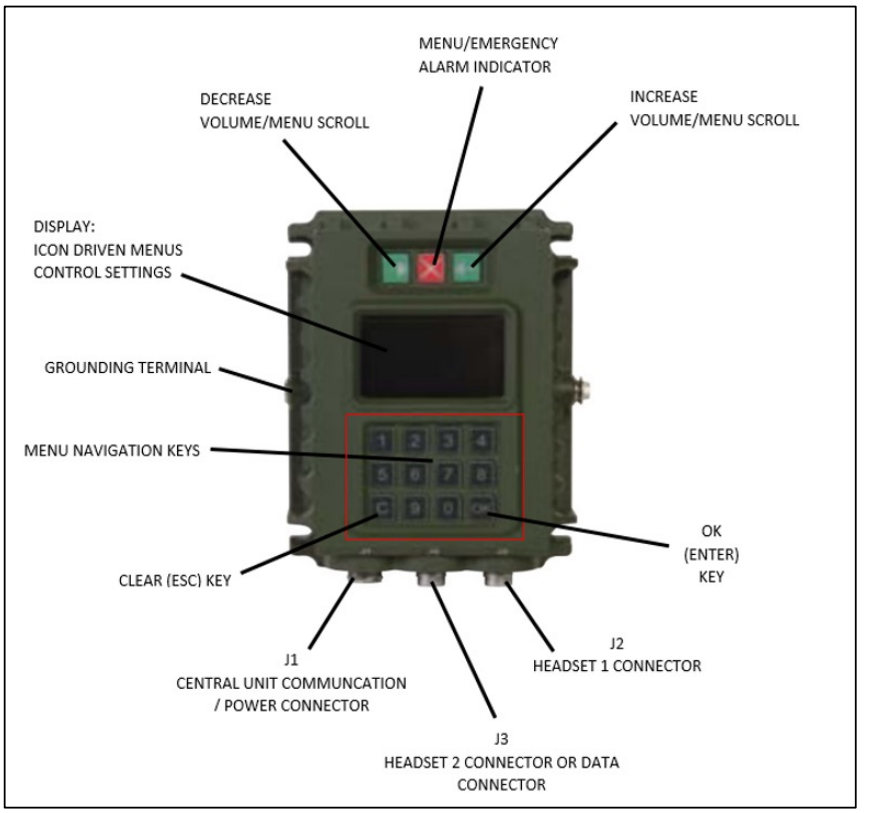


Figure 3: *RF-7800I-KD Keypad Display Unit front view.*

Single key strokes access the intercom and radio channels while programmable soft keys enable wide range of customiseable, advanced features. Ordering options include the choice of a second headset port or data port to support a personal computer (PC) or other data.

3.2.2 RF-7800I Rotary Dial (RD) Unit

The RF-7800I-RD Rotary Dial Unit provides operators with access to 16 programmable modes of operation through a one-knob switch interface.

3.2.3 RF-7800I Basic (BU) Unit

The RF-7800I-BU Basic Unit provides operators with access to a single pre-programmed mode of operation and a hands-free user-interface. Operator controls for the Basic Unit is three-button interface located on top of the unit.

4. Additional hardware

The RF-7800I Speaker Unit is one of additional hardware options available for all RF-7800I configurations.

4.1 RF-7800I-SA Speaker Unit

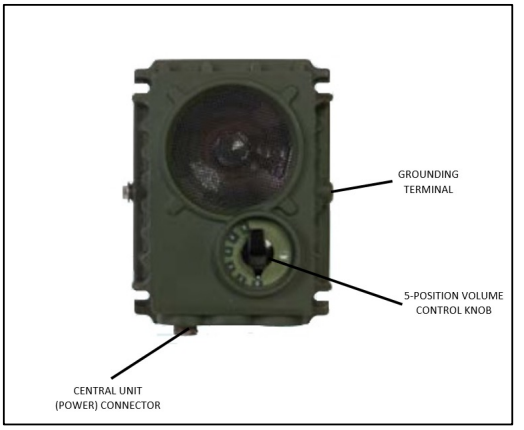


Figure 6: *RF-7800I-SA Speaker Unit front view.*

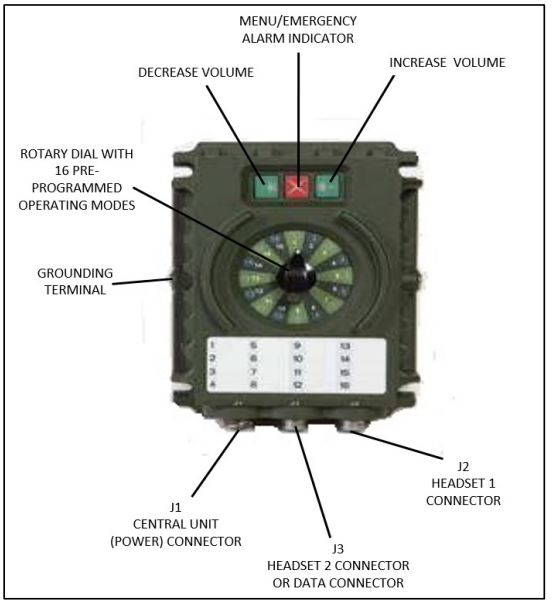


Figure 4: *RF-7800I-RD Rotary Dial Unit front view.*

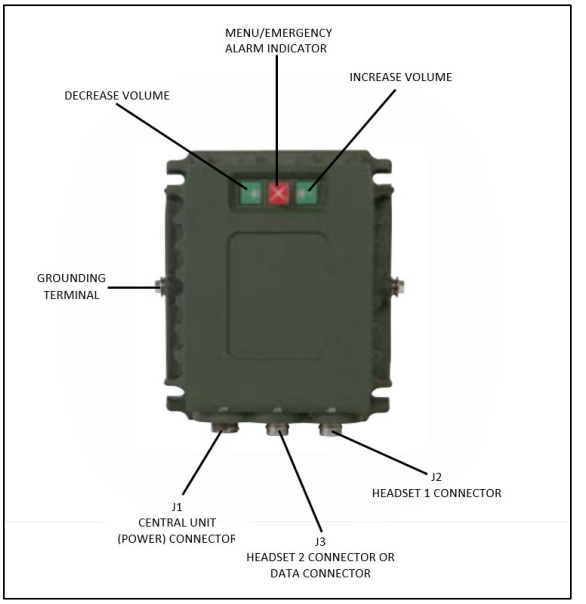


Figure 5: *RF-7800I-BU Basic Unit front view.*

4.2 Headsets RACAL Acoustics RA5000

The RF-7800I Crew Stations unit need RACAL Acoustics RA5000 headset to deliver combined Passive and Active Noise Reduction (ANR) for excellent speech intelligibility and hearing protection. The in-line press-to-talk (PTT) control unit contains a three-position PTT toggle switch, talk-through on/off button and a respirator/gas mask microphone socket (overrides the boom microphone).

Figure 7: *RACAL Acoustic RA5000 Speaker Unit*

5. Basic operation

5.1 Interconnection

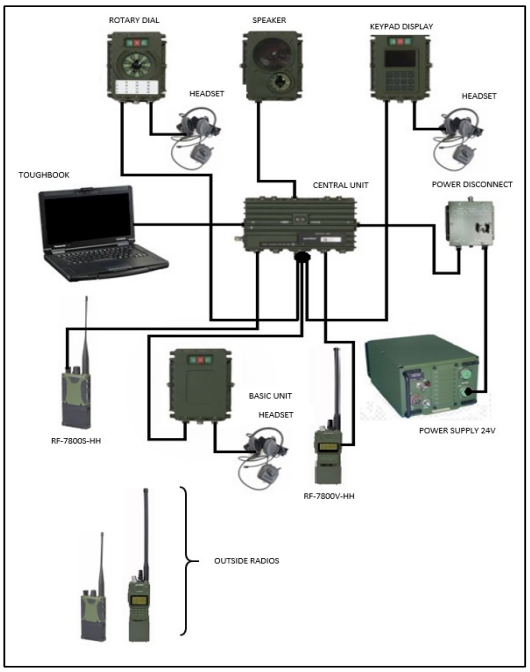


Figure 8: *Interconnection of RF-7800I Vehicular Intercom System.*

5.2. Block diagram

Figure 9 shows a block diagram of how the RF-7800I Vehicular Intercom System operates.

- Power supply from AC to DC converter of RF-5051-PS001 giving an output of 24V and an input to Power Disconnect HARRIS/ RF Communication.
- The Power Disconnect giving supply of 18-32V to the Central Unit.
- Central Unit will give a power supply to all Crew Stations Unit using an “Octopus Cable” of 12106-1324-A002 and speaker.
- Central Unit and all the Crew Stations are pre-programmed using RF-7800I Digital Intercom System Control Center (DCC) software dependent on the individual vehicle configuration and/or mission requirements.
- RF-7800I Vehicular Intercom System will do the broadcasting to the outside radios. It can do retransmission by using RF-7800I-KD Keypad Display Unit.

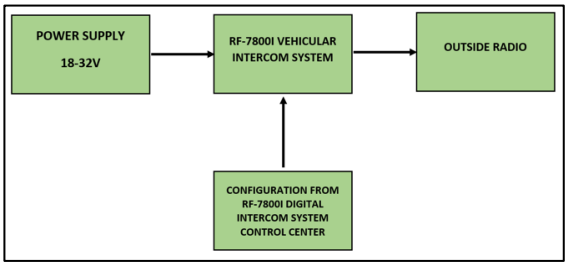


Figure 9: *Block Diagram of RF-7800I Vehicular Intercom System Basic Operation.*

6. Design and construction

Before proceeding to an actual outcome of Portable Compact Intercom Simulator, the sketch of the the design layout for the positioning of the the RF-7800I Vehicular Intercom System inside a tough box was produced using the SketchUp software. This was then followed by some constructions process of its mechanism and interconnection.

6.1 Layout design

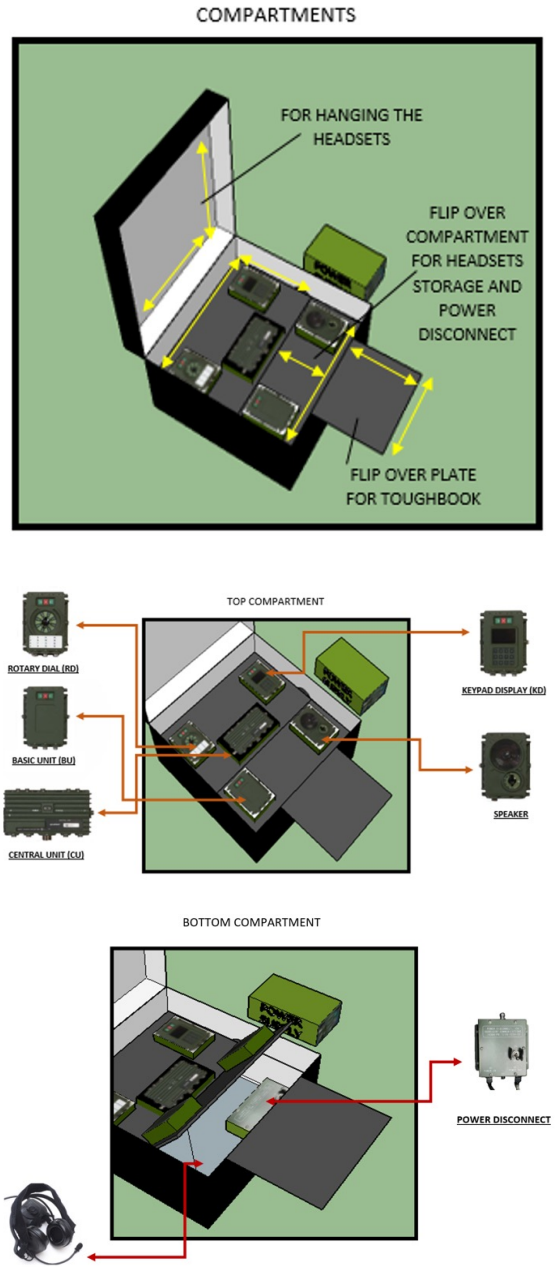


Figure 10: *Layout design.*

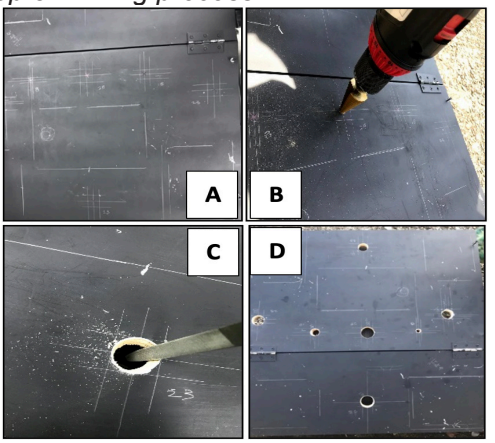
6.2 Construction

The system was built and constructed in a tough black box to support RF-7800I Vehicular Intercom System to become a simulator and transportable.

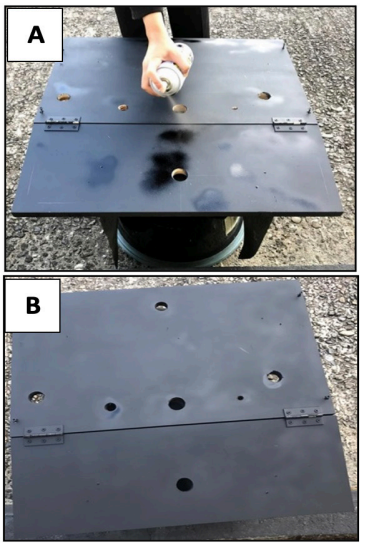
Step 1: Finding the right tough box and portable

Step 2: Building and constructing a platform

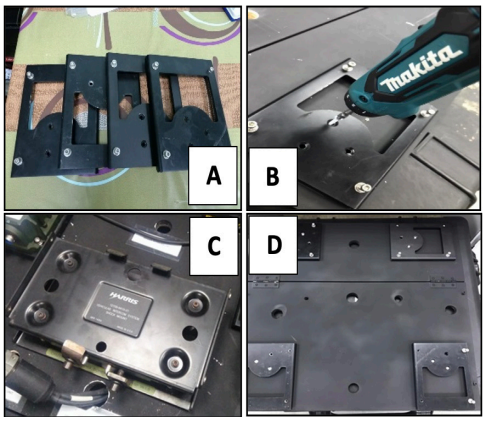
Step 3: Drilling process.



Step 4: Painting/spraying colour.



Step 5: Mounting installation.



Step 6: Cable installation.

CREW STATIONS CABLE

ETHERNET CABLE

SPEAKER CABLE

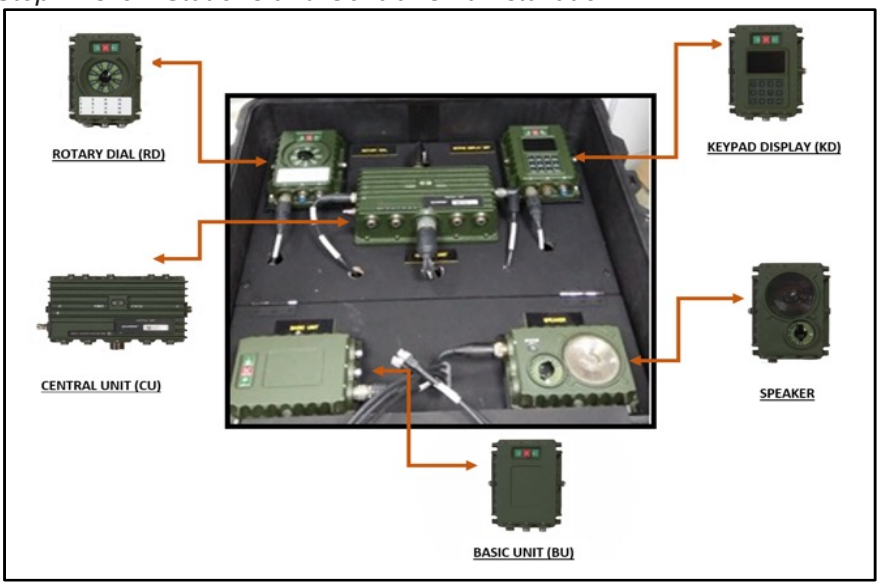
12106-1324-A002 (OCTOPUS CABLE)

After Installation

TOP VIEW

BOTTOM VIEW

Step 7: Crew Stations and Central Unit installation



Step 8: Hook intsallation for hanging the headsets.

7. Testing and troubleshooting

Testing and troubleshooting of RF-7800I Vehicular Intercom System with radios were conducted after all the installations to ensure the portable compact intercom simulator runs smoothly and successful.

Figure 11: *Testing and troubleshooting.*

8. Results

Figure 12: *Before assembly.*

Figure 13: *After assembly.*

9. Project cost

Table 2 provides the breakdown of costs.

Table 2: *Breakdown of costs.*

No	Items	Cost
1	Pelican Black Box	$529.50
2	Wood For Platform	$50.00
3	Drill Bit	$2.50
4	Spray	$7.20
5	Hook for Headsets	$1.20
6	Screws	$2.00
	Total	**$592.40**

10. Conclusion

The Portable Compact Intercom Simulator is a successful project that has met all its objectives. It is a fully operational, compact and portable intercom simulator that can be used for RF-7800I Vehicular Intercom System maintenance and fault finding. This project can contribute in providing assisance to both military and civilian in all aspects, such as conducting courses, training and operational missions.

11. Recommendations

- Direct power supply using batteries
- Wireless – Bluetooth and Frequencies
- Smaller and lightweight box

Figure 14: *Portable Compact Intercom Simulator.*