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Development of a Driver Alert System (DAS) for the Bradley Fighting Vehicle

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for

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U. S. Army
Research Institute for the Behavioral and Social Sciences

July 1988

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Gerald I. Dewey

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Observation of Bradley Fighting Vehicles (BFVs) in the field revealed a potential for communication problems between drivers and commanders. Since communication was by intercom only, electrical failure, battle damage, unplugging or removal of the driver's CVC helmet, or interference from platoon radio traffic could disrupt the system. For this reason, an emergency/backup driver alert system was developed. An audible two tone warbler alerting device was fitted into the driver's compartment, and an activating switch was placed (OVER)

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20. Abstract (continued)

in the commander's compartment. Very preliminary research data appears to indicate that this is an effective way for the driver and commander to ensure that they remain in contact.

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FOREWORD

The Army Research Institute (ARI) has contributed to a program to define emerging problems and address critical issues affecting the Bradley Fighting Vehicle (BFV). Consistent with that program, this report describes a method of installing a two-tone audible driver alert system (DAS) that can be used by the commander to signal the driver in situations where the intercom system has failed, or cannot be used because of incoming radio traffic, or where the driver does not/cannot respond to the intercom. It is expected that this modification will foster improvement in the combat capability of the BFV.

ARI's Fort Benning Field Unit, a division of the Training Research Laboratory, monitored the research reported here. ARI's mission is to conduct research on training and training technology using infantry combat systems and problems as mediums. The research task which supports this mission is 3.4.2., Advanced Methods and Systems for Fighting Vehicle Training and is organized under the 'Train the Force' program area. Sponsorship for this research effort is provided by a Memorandum of Understanding (effective 31 May 1983) between the U.S. Army Infantry School (USAIS), TRADOC, Training Technology Agency and ARI which established how joint efforts to improve BFV tactical doctrine, unit, and gunnery training would proceed.

Feedback from frequent in process reviews and briefings to USAIS and 1st Battalion, 29th Infantry Regiment suggests that the research project reported here will improve the capabilities of BFV personnel.

DEVELOPMENT OF A DRIVER ALERT SYSTEM (DAS) FOR THE BRADLEY FIGHTING VEHICLE

EXECUTIVE SUMMARY

Requirement:

Litton Computer Services (LCS) operated under contract to and with guidance from the Army Research Institute (ARI) located at Fort Benning, Georgia. The researchers were tasked with investigating ways of increasing the operational effectiveness of the Bradley Fighting Vehicle (BFV).

Procedure:

Observation of BFVs in the field revealed a potential for communication failure between the Bradley commander (BC) and the driver, which could inhibit the vehicle's ability to respond rapidly to changing situations. Communication between the BC and the driver is by intercom. Electrical failure, battle damage, unplugging or removal of the driver's CVC helmet, and interference from incoming platoon radio traffic can disrupt this system. It was determined that an emergency/backup driver alert was needed.

Findings:

An audible two-tone warble alerting device was fitted in the driver's compartment, and an activating switch was attached to the commander's position indicator. The signal was of a loudness, pitch and tonal quality to alert a driver, could be detected easily when the engine was running, and yet was not so loud as to constitute a hazard to the driver's hearing, or to present any additional threat to the safety of the vehicle during silent watch operations.

Utilization of Findings:

The system may be used to alert a driver whose intercom has become disconnected, to awaken a driver who has fallen asleep, or to alert a driver to an impending move when turret power is off and the intercom is not working. In addition, when the vehicle is travelling, the driver alert system may be used as emergency-stop signal.

DEVELOPMENT OF A DRIVER ALERT SYSTEM (DAS) FOR THE BRADLEY FIGHTING VEHICLE

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DEVELOPMENT OF A DRIVER ALERT SYSTEM (DAS)
FOR THE BRADLEY FIGHTING VEHICLE

The survivability of a Bradley Fighting Vehicle (BFV) depends, in large part, on rapid response and movement in changing battle conditions. This implies and requires an efficient communication system between crew members, particularly between the commander and the driver. Loss of communication between the commander and driver may be a critical problem. The effects of loss of communication are compounded during extended field exercises when mental fatigue and physical exhaustion degrade alertness levels. Researchers noted an example of this during an exercise, when a vehicle was left behind as a platoon moved out because the driver had fallen asleep and had to be physically roused.

The commander communicates with the driver by using the vehicle intercom system. This system has certain difficulties; for example, radio traffic can interfere with intercom usage. If the intercom fails because of battle damage or electrical malfunction, or because the driver has removed or unplugged his combat vehicle crewman's (CVC) helmet or is so exhausted that he falls asleep, then the communication system breaks down and messages must be physically transmitted to the driver. If the dismount element is on board, messages can be passed via the number four man to the driver. If the dismount element is deployed, then either the commander or the gunner must leave the turret to give orders to the driver. Clearly, the delay involved in using these expedients is undesirable and reduces the capability for rapid response.

Researchers identified the need for an alternative or backup system for the intercom, to allow the commander to alert or signal the driver. The purpose of this document is to report developmental work on an audible driver alert system (DAS) for the BFV. The DAS enables a BFV commander to signal the driver when the intercom system has failed, cannot be used, or when the driver fails to respond to the intercom.

METHOD

The system design required that it provide a rapid and reliable alternative method by which the commander could alert the driver to an immediate need for action. The system should be capable of easy and inexpensive retrofit to fielded BFVs and be both reliable and easy to operate. A visual alert was rejected because it would not wake a sleeping driver. Tactile alerts were rejected because they rely on attachments to the body; these are easily ignored and would be incompatible with wearing nuclear, biological, and chemical (NBC) clothing. Therefore, an auditory alert was selected.

Specification of an audible DAS entailed four additional constraints. First, it had to be loud enough to be clearly detectable by the driver above the vehicle's engine noise. Second, the signal generated had to have properties that were likely to attract the driver's attention. Third, it could not be so loud as to be detectable at distances beyond 500 meters from the vehicle during silent watch missions. Last, the loudness of the signal could not be so great as to risk inducing hearing damage to the driver.

The development of a DAS had three major steps. The first was to determine and specify the optimum loudness, pitch and tonal quality for the auditory alert. Secondly, after development of the system, it had to be installed on a BFV, and sound output measured. Finally, it had to be tested to ensure it met operational requirements and constraints.

Sound Level Specifications

As an initial step, the research team made an octave band analysis of sound pressure levels found at the driver's head position on a BFV. For this purpose, the engine, turret power, and ventilation fan were turned on. The sound pressure level registered 96 decibels with A-weighting (dBA). The octave band analysis showed that the sound energy was concentrated in the low- to mid-frequency octave bands. (See Table 1, Appendix A.)

As a result of the analysis, the research team determined that the pitch of the DAS should fall within the four kilohertz (KHz) octave band (approximately 2666-5332 Hz), preferably at about 3000 Hz. This recommendation was made for two reasons; first, this frequency falls within the range to which the human ear is most sensitive; and second, because the vehicle generates less sound energy in the four KHz octave band (84 dB) than at lower frequencies, a reduced sound level can be specified for the alert while preserving a signal clearly detectable above vehicular noise.

With sound level specifications established, the researchers obtained a selection of commercially available audible alert devices that approximated the requirements and conducted limited tests to evaluate tonal quality. The alerts were all small electronic devices measuring not more than 3 x 3 x 2 inches. Three basic types were tested: those that gave a continuous, one-note signal in a narrow frequency band, and that could be made intermittent by turning them on and off; those that gave an automatic intermittent narrow band signal; and those that gave an oscillating signal (two-tone warble). The investigators concluded that the oscillating note was the most difficult to ignore and therefore the most likely to alert a driver, even when he was sleeping.

Installation and Operational Test of the DAS

The system that was installed on a BFV used a two-tone warble, piezo alert (See Figure 1). It was of slightly lower pitch than was recommended (resonant frequency 2500 Hz + or - 500 Hz), and was rated by the manufacturer as delivering a minimum of 100 dB when measured at 30 cm (11 3/4 inches) from the source. The noise level could be increased by 15 dB by opening attenuating vanes on the front.

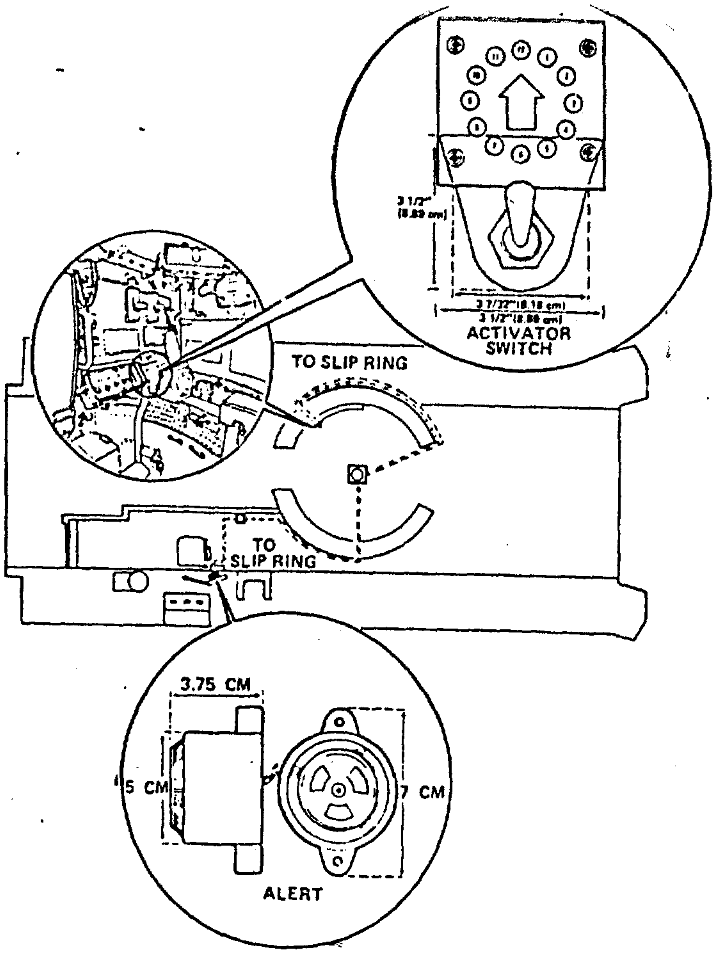


Figure 1. Design and location of the driver alert system (DAS). (Sample DAS manufactured by the Tandy Corporation for Radio Shack.)

The alert signal generator was fastened to a stanchion in the driver's compartment using two plastic cable ties. It was located to the left and rear of the driver, at a distance of approximately 24 inches from his left ear and on a level with his shoulder. The DAS was connected via two of the seven spare circuits on the slip ring to an activator switch in the turret. This switch was mounted on a small plate that was attached to the front of the commander's turret position indicator. (Detailed installation instructions are given in Appendix B.)

The research team measured the noise levels at the driver's head position (24 inches from source) and found that the device would deliver 96 dBA with the attenuating vanes closed, and 106 dBA with them open. The device was set at its lowest setting (96 dBA), and an octave band analysis was made of noise levels at the driver's head position with and without the DAS in continuous operation.

This analysis showed that the DAS increased noise levels in both the 2 KHz and 4 KHz octave bands by approximately 9 dB. (See Appendix A, Table 2.) The 96 dBA setting was more than sufficient to make the alert easily detectable to a driver above engine noise. However, it was thought inadvisable to reduce the level further because ambient noise levels may be higher than those recorded;

as, for example, when a platoon of BFVs is operating in close proximity, or during battle.

From a hearing safety viewpoint, the noise levels generated by the vehicle itself, as measured in the driver's position (96 dBA), already exceed the Surgeon General's recommendation for maximum exposure levels (85 dBA). For this reason, the driver is required to wear a CVC helmet. The CVC attenuates noise in the 2 KHz and 4 KHz octave bands by 30 dB and 35 dB respectively, so that the DAS presents no additional threat to the driver's hearing (See Appendix A, Table 3). The alert signal would be used intermittently and infrequently, so daily exposure would be minimal.

RESULTS AND DISCUSSION

To determine the distance at which the alert could be heard outside the vehicle, a researcher walked away from the vehicle first downwind and then upwind and indicated by raising his hand when he heard the alert signal activated. (The individual had been audiometrically tested, and had zero dB hearing loss at test frequencies between 1 KHz and 4 KHz and only 5 dB at 6 KHz.) The test was conducted with all vehicle systems turned off, with all hatches open, and with the ramp down. As the test subject walked away, the alert signal was sounded at irregular intervals. Each sounding comprised three rapid activations of approximately one-second duration with a one-second interval between the activations.

At the 96 dBA setting, the subject could no longer detect the alert signal when he was 400 meters downwind, or 70 meters upwind, of the vehicle. Wind strength was variable between 10 and 15 mph. These distances are less than the distances at which the vehicle engine can be heard starting up under similar conditions. Because the DAS is used to alert the driver to the need to start the engine, its use puts the vehicle at no additional risk of detection.

The DAS was tested during a regularly scheduled field exercise. During this time, the commander reported twice making use of the DAS to alert the driver. The first occasion was early in the exercise, at a time when the driver was still well rested (four hours since he had last slept). Its next use was after the driver had been without sleep for 16 hours. On both occasions, the vehicle was stationary with the engine running and the driver's CVC was unplugged; however, the driver responded to the alert immediately.

Both the driver and commander completed questionnaires after the exercise. The driver reported the volume of the alert and its location satisfactory, but said he would have preferred a lower pitch. He suggested that a second activating switch be installed in the crew compartment to signal the driver when the ramp was clear. The vehicle commander endorsed the latter suggestion. The commander felt that his activator switch was not well located, and suggested that it be moved below the weapons control panel where it would also be within easy reach of the gunner.

The DAS was not removed from the vehicle. A check, made three months after installation, showed that it was still working correctly, partial indication of reliability. Interviews with four persons who had commanded the vehicle indicated that the DAS had been used on at least five occasions to awaken sleeping drivers, and that it had been effective in doing so even when a driver was wearing his CVC helmet. One commander related that when moving in convoy, he had used the DAS to alert the driver to intercom failure. The driver reacted by immediately pulling the vehicle off the road. As a result of this experience, the commander suggested that when the vehicle is travelling, the DAS can be used as an emergency stop warning system for the driver. Another commander reported that, when all systems were closed down, he had used the DAS to alert the driver that a move was imminent. When the master power and turret power are off, the intercom will not operate, but because the DAS is battery powered, it functions.

CONCLUSIONS

The prototype alert device met the established operational requirements and design constraints. It provided an attention-demanding sound at a loudness that made it easily detectable to the driver when engine and ventilation systems were operating. It was not loud enough to betray the BFV's position when the vehicle was on silent watch; it is quieter than other on-board systems likely to be in use at a time when the DAS is required. Such a system would be relatively inexpensive, and installation by Direct Support is estimated at less than two hours. The DAS provides a valuable backup to the intercom system to help ensure rapid response. Its further use as an emergency-stop alarm, has obvious safety value when the vehicle is maneuvering. Based on the success of the initial exploration of the concept, it is recommended that driver alert systems be installed in a number of vehicles for full field evaluation.

APPENDIX A

SOUND MEASUREMENTS

All sound measurements were made using a Bruel & Kjaer (B&K) precision sound pressure level meter (Type 2209) fitted with a B&K extension octave filter (Type 1613) and a one-inch condenser microphone (Type 4145). The sound level meter was calibrated prior to taking measurements and rechecked at the conclusion using a B&K (Type 4220) pistonphone.

Table 1

Octave Band Analysis of Noise Levels at Driver's Head Position

			Octave band center frequencies									
	dB	dBA	31.5	63	125	250	500	1k	2k	4k	8k	16k
Vehicle A	101	96	96	94	94	89	89	92	88	84	76	69

Note. Measure taken with engine and turret power on; blower on high setting.

Table 2

Octave Band Analysis of Noise Levels at Driver's Head Position With and Without the DAS

			Octave band center frequencies									
	dB	dBA	31.5	63	125	250	500	1k	2k	4k	8k	16k
Vehicle B	100	96	92	96	93	87	92	87	87	92	72	62
Vehicle B with DAS	102	100	92	91	92	88	92	87	97	91	76	66

Note. Measures taken with engine and turret power on and blower on high setting; DAS activation switch was held down for continuous signal.

Table 3

Attenuation of Sound Levels by CVC helmet.

	Octave band center frequencies							
	125	250	500	1k	2k	4k	8k	16k
Attenuation by CVC [dB]	15	14	24	28	30	35	35	30

Note. Source: Sachs, F. Z. (1982, October). *Request for waiver of noise limits in the vehicle interior of the Infantry Fighting Vehicle (M2) and Cavalry Fighting Vehicle (M3)*. Letter written by HSHB-OA, U.S. Army Environmental Hygiene Agency.

APPENDIX B

INSTALLATION INSTRUCTIONS FOR THE DRIVER ALERT SYSTEM

INSTALLATION PROCEDURE

DRIVER ALERT SYSTEM (DAS)

INITIAL SETUP

Tools:

110/220 Volts Power Supply
Electric Desoldering and Soldering Set, NSN 3439-00-460-7198
Electric Heat Gun, NSN 4940-00-438-1606

Materials/Parts:

Archer piezo alert (Tandy Corporation Catalogue # 273-070)
1-Way Activator Switch
32 Feet of Electrical Wire, NSN 6145-00-177-4607
2 Contact Pins, NSN 5940-00-399-6676
32 Feet of Insulating Sleeving, NSN 5970-00-815-1295
25 Cable Ties

References:

TM 9-2350-252-34-2
TM 9-2340-252-20-2
TM 55-1500-323-25

Personnel Required:

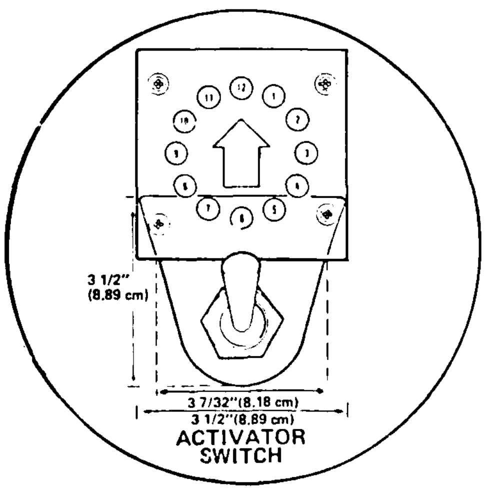
Organizational Maintenance

General Safety Instructions:

****
* WARNING *
****

You must disconnect the vehicle main ground before beginning.

NOTE: YOU MUST MAKE A MOUNTING BRACKET FOR THE DAS ACTIVATOR SWITCH BEFORE UNDERTAKING THIS PROCEDURE. THE BRACKET MUST BE MADE OF STEEL OR ALUMINUM THAT IS AT LEAST 1/8-IN. (3-MM) THICK. AN EXAMPLE OF A DESIGN FOR THE BRACKET IS ILLUSTRATED BELOW.



INSTALLATION PROCEDURE

DRIVER ALERT SYSTEM (DAS)

NOTE: THE FOLLOWING STEPS CAN BE PERFORMED BY ORGANIZATIONAL MAINTENANCE

1. REMOVE THE FLOOR PLATES FROM THE TURRET CENTER AND TURRET STEP. See TM 9-2340-252-20-2.

2. DISCONNECT THE 1W5-P2 AND 2W2-P1 CONNECTORS FROM THE SLIP RING AND LOOSEN THE CABLE CLAMPS AS NECESSARY TO ALLOW ACCESS FOR MODIFYING THE CABLES AND CONNECTORS.

---

3. CUT 8 FT (2.4 M) OF ELECTRICAL WIRE TO MAKE AN EXTENSION WIRE FOR THE 2W2-P1 CONNECTOR.

4. COVER THE 2W2-P1 EXTENSION WIRE WITH 8 FT (2.4 M) OF INSULATING SLEEVING.

5. CRIMP A CONTACT PIN ONTO THE EXTENSION WIRE.

6. INSERT THE CONTACT PIN SECURELY INTO THE **T** POSITION OF THE 2W2-P1 CONNECTOR. See TM 9-2350-252-34-2.

---

7. CUT 10 FT (3.1 M) OF ELECTRICAL WIRE TO MAKE AN EXTENSION WIRE FOR THE 1W5-P2 CONNECTOR.

8. COVER THE 1W5-P2 EXTENSION WIRE WITH 10 FT (3.1 M) OF INSULATING SLEEVING.

9. CRIMP A CONTACT PIN ONTO THE EXTENSION WIRE.

10. INSERT THE CONTACT PIN SECURELY INTO THE **T** POSITION OF THE 1W5-P2 CONNECTOR. See TM 9-2350-252-34-2.

11. RESEAL ALL CABLES AND CONNECTORS.

INSTALLATION PROCEDURE

DRIVER ALERT SYSTEM (DAS)

12. CUT 8 FT (2.4 M) OF ELECTRICAL WIRE TO MAKE A POWER WIRE.

13. COVER THE POWER WIRE WITH 8 FT (2.4 M) OF INSULATING SLEEVING.

14. ATTACH THE POWER WIRE TO THE POSITIVE TERMINAL OF THE RIGHT HAND TURRET BATTERY.

---

15. ROUTE THE 2W2-P1 EXTENSION WIRE AND THE POWER WIRE UNDER THE FLOOR PLATES TO THE STANCHION LOCATED IN FRONT OF THE COMMANDER'S RIGHT KNEE POSITION.

16. CONTINUE ROUTING THE 2W2-P1 EXTENSION WIRE AND POWER WIRE UP THE STANCHION AND SECURE BOTH WIRES TO THE STANCHION WITH CABLE TIES.

---

17. CONNECT THE POWER WIRE TO ONE OF THE TWO NON-GROUND TERMINALS ON THE DAS ACTIVATOR SWITCH.

18. CONNECT THE 2W2-P1 EXTENSION WIRE TO THE REMAINING NON-GROUND TERMINAL ON THE DAS ACTIVATOR SWITCH.

---

19. CUT 18 IN. (46 CM) OF ELECTRICAL WIRE TO MAKE A GROUND WIRE FOR THE DAS ACTIVATOR SWITCH.

20. COVER THE GROUND WIRE WITH 18 IN. (46 CM) OF INSULATING SLEEVING.

21. CONNECT THE GROUND WIRE TO THE GROUND TERMINAL ON THE DAS ACTIVATOR SWITCH.

22. ROUTE THE GROUND WIRE FROM THE DAS ACTIVATOR SWITCH TO THE COMMANDER'S DOME LIGHT GROUND POINT.

---

23. SECURE THE DAS ACTIVATOR SWITCH TO THE MOUNTING BRACKET.

24. SECURE THE MOUNTING BRACKET TO THE COMMANDER'S TURRET POSITION INDICATOR. (USE EXISTING SCREWS)

INSTALLATION PROCEDURE

DRIVER ALERT SYSTEM (DAS)

25. ROUTE THE 1W5-P2 EXTENSION WIRE ALONG THE 1W5 CABLE, SECURING BOTH WIRES TOGETHER WITH CABLE TIES AS YOU GO.

26. ROUTE THE 1W5-P2 EXTENSION WIRE UNDER THE FLOOR PLATES BEHIND THE DRIVER'S SEAT AND UP THE DRIVER'S SEAT STANCHION AND SECURE THE EXTENSION WIRE WITH CABLE TIES.

27. CONNECT THE 1W5-P2 EXTENSION WIRE TO THE POWER WIRE ON THE PIEZO ALERT HOUSING.

---

28. CUT 18 IN. (46 CM) OF ELECTRICAL WIRE TO MAKE A GROUND WIRE FOR THE PIEZO ALERT.

29. COVER THE GROUND WIRE WITH 18 IN. (46 CM) OF INSULATING SLEEVING.

30. CONNECT THE GROUND WIRE TO THE REMAINING WIRE ON THE PIEZO ALERT.

31. ROUTE THE GROUND WIRE FROM THE PIEZO ALERT TO THE DRIVER'S DOME LIGHT GROUND POINT.

32. SECURE THE PIEZO ALERT TO THE TOP OF THE DRIVER'S SEAT STANCHION USING CABLE TIES.

33. SECURE THE GROUND WIRE USING CABLE TIES.

---

34. CHECK ALL CONNECTIONS.

35. RECONNECT THE VEHICLE'S MAIN GROUND.

36. PERFORM A FUNCTION TEST OF THE DRIVER ALERT SYSTEM.

FINISHED

INSTALLATION PROCEDURE

DRIVER ALERT SYSTEM (DAS)

NOTE: THE FOLLOWING STEPS CAN BE PERFORMED BY ORGANIZATIONAL MAINTENANCE

1. REMOVE THE FLOOR PLATES FROM THE TURRET CENTER AND TURRET STEP. See TM 9-2340-252-20-2.

2. DISCONNECT THE 1W5-P2 AND 2W2-P1 CONNECTORS FROM THE SLIP RING AND LOOSEN THE CABLE CLAMPS AS NECESSARY TO ALLOW ACCESS FOR MODIFYING THE CABLES AND CONNECTORS.

3. CUT 8 FT (2.4 M) OF ELECTRICAL WIRE TO MAKE AN EXTENSION WIRE FOR THE 2W2-P1 CONNECTOR.

4. COVER THE 2W2-P1 EXTENSION WIRE WITH 8 FT (2.4 M) OF INSULATING SLEEVING.

5. CRIMP A CONTACT PIN ONTO THE EXTENSION WIRE.

6. INSERT THE CONTACT PIN SECURELY INTO THE **T** POSITION OF THE 2W2-P1 CONNECTOR. See TM 9-2350-252-34-2.

7. CUT 10 FT (3.1 M) OF ELECTRICAL WIRE TO MAKE AN EXTENSION WIRE FOR THE 1W5-P2 CONNECTOR.

8. COVER THE 1W5-P2 EXTENSION WIRE WITH 10 FT (3.1 M) OF INSULATING SLEEVING.

9. CRIMP A CONTACT PIN ONTO THE EXTENSION WIRE.

10. INSERT THE CONTACT PIN SECURELY INTO THE **T** POSITION OF THE 1W5-P2 CONNECTOR. See TM 9-2350-252-34-2.

11. RESEAL ALL CABLES AND CONNECTORS.

DRIVER ALERT SYSTEM (DAS)

12. CUT 8 FT (2.4 M) OF ELECTRICAL WIRE TO MAKE A POWER WIRE.

13. COVER THE POWER WIRE WITH 8 FT (2.4 M) OF INSULATING SLEEVING.

14. ATTACH THE POWER WIRE TO THE POSITIVE TERMINAL OF THE RIGHT HAND TURRET BATTERY.

---

15. ROUTE THE 2W2-P1 EXTENSION WIRE AND THE POWER WIRE UNDER THE FLOOR PLATES TO THE STANCHION LOCATED IN FRONT OF THE COMMANDER'S RIGHT KNEE POSITION.

16. CONTINUE ROUTING THE 2W2-P1 EXTENSION WIRE AND POWER WIRE UP THE STANCHION AND SECURE BOTH WIRES TO THE STANCHION WITH CABLE TIES.

---

17. CONNECT THE POWER WIRE TO ONE OF THE TWO NON-GROUND TERMINALS ON THE DAS ACTIVATOR SWITCH.

18. CONNECT THE 2W2-P1 EXTENSION WIRE TO THE REMAINING NON-GROUND TERMINAL ON THE DAS ACTIVATOR SWITCH.

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21. CONNECT THE GROUND WIRE TO THE GROUND TERMINAL ON THE DAS ACTIVATOR SWITCH.

22. ROUTE THE GROUND WIRE FROM THE DAS ACTIVATOR SWITCH TO THE COMMANDER'S DOME LIGHT GROUND POINT.

---

23. SECURE THE DAS ACTIVATOR SWITCH TO THE MOUNTING BRACKET.

24. SECURE THE MOUNTING BRACKET TO THE COMMANDER'S TURRET POSITION INDICATOR. (USE EXISTING SCREWS)

INSTALLATION PROCEDURE

DRIVER ALERT SYSTEM (DAS)

25. ROUTE THE 1W5-P2 EXTENSION WIRE ALONG THE 1W5 CABLE, SECURING BOTH WIRES TOGETHER WITH CABLE TIES AS YOU GO.

26. ROUTE THE 1W5-P2 EXTENSION WIRE UNDER THE FLOOR PLATES BEHIND THE DRIVER'S SEAT AND UP THE DRIVER'S SEAT STANCHION AND SECURE THE EXTENSION WIRE WITH CABLE TIES.

27. CONNECT THE 1W5-P2 EXTENSION WIRE TO THE POWER WIRE ON THE PIEZO ALERT HOUSING.

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33. SECURE THE GROUND WIRE USING CABLE TIES.

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35. RECONNECT THE VEHICLE'S MAIN GROUND.

36. PERFORM A FUNCTION TEST OF THE DRIVER ALERT SYSTEM.

FINISHED