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<tr>
<td>ABOC</td>
<td>Airbase Operations Centre</td>
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<td>ADR</td>
<td>Airfield Damage Repair</td>
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<td>AM2</td>
<td>American Matting 2</td>
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<td>ASR</td>
<td>Airfield Scab Repair</td>
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<td>BDRM</td>
<td>Bomb Damage Repair Mat</td>
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<tr>
<td>DROPS</td>
<td>Demountable Rack Offloading Platform System</td>
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<tr>
<td>EOD</td>
<td>Explosive Ordnance Disposal</td>
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<td>MOS</td>
<td>Minimum Operating Strip</td>
</tr>
<tr>
<td>NATO</td>
<td>North Atlantic Treaty Organisation</td>
</tr>
<tr>
<td>PSP</td>
<td>Pierced Steel Planking</td>
</tr>
<tr>
<td>RAF</td>
<td>Royal Air Force (UK)</td>
</tr>
<tr>
<td>RES</td>
<td>Restoration of Essential Services</td>
</tr>
<tr>
<td>SHORAD</td>
<td>Short Range Air Defence</td>
</tr>
<tr>
<td>SOP</td>
<td>Standard Operating Procedure</td>
</tr>
<tr>
<td>STO</td>
<td>Survive to Operate</td>
</tr>
<tr>
<td>UK MOD</td>
<td>United Kingdom Ministry of Defence</td>
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<td>WWII</td>
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SURVIVE TO OPERATE: A GUIDE TO AIRFIELD DAMAGE REPAIR
The combat power of modern military aircraft is so important that modern warfare usually begins with a counter-air battle. Initial strikes by enemy aircraft will be designed to neutralise an airforce.

One of the surest methods is to destroy or damage runways and other essential facilities. If an airforce cannot fly it cannot fight; if it cannot fight, all the resources, allocated over many years to create that airforce, resources of both people and money, will have been wasted. Therefore it makes sound military sense to plan for airfield survival and implement that plan by procuring the necessary equipment in peacetime. It is too late once hostilities have started.

Weapons for closing airfields are available widely so that it must be assumed that any enemy will have them.

RAF bases in UK have faced a high threat for many years, thus the British Royal Engineers, who are responsible for the construction engineering for the RAF in war, developed ‘Airfield Damage Repair’ (ADR) concepts and material. In British practice, ADR may be defined as “the works in war that are required to allow aircraft to operate from a base that has been closed by enemy attack”. ADR is not about repairing all of the bomb damage that has occurred. ADR is to restore facilities on the airbase that are essential before flying can be resumed and thus ADR is an essential element in the capability of a base to ‘Survive to Operate’.

ADR may be considered the fastest possible execution of a sixphase, post-attack, battle-procedure.

The techniques described in this guide were developed and designed to meet the needs of the Royal Air Force (RAF) in the UK. This does not imply that the UK RAF solution is appropriate for every country; national circumstances will require a tailored solution. The provision for ADR made by the UK RAF however is widely acknowledged to be the most professional in NATO.

The information in this guide has been extracted from a report on ‘Airfield Survivability’ by Colonel (R) Bruce Brown, R.E. MBE UK MOD.
The object of survivability is to keep the airfield operational following enemy attack or if that is not achieved, to return the airfield to operational status within a minimum timescale. The enemy attack may be made by air, sea or land, using free flight and guided missiles, bombs and/or multiple specialist airfield denial munitions.

The responsibility for ensuring ‘survivability’ rests with the Air Staff, it is not a matter that should be left to logistic and maintenance branches. It may of course be these branches which have to implement Air Staff policy.

In the Royal Air Force, there is a branch within the Air Staff named ‘Survive to Operate’ (STO) who formulate policy on behalf of the Chief of Air Staff. The concept of STO is a combination of active and passive defence measures, which are:

- Physical Protection
- Dispersal of Assets
- **Airfield Damage Repair**
- Short Range Air Defence (SHORAD)
- Camouflage, Tone Down and Deception

To be successful a balanced combination of these measures must be employed. Airfield Damage Repair is unique as once the airfield has been closed by enemy action, flying operations can only be resumed if proper Airfield Damage Repair capability is immediately available. Therefore it is essential that the strategy is adopted in peacetime, to allow for procurement of equipment and essential training for personnel.
In all military business there must be a clear Concept of Operations. In the RAF, ADR is a joint operation that employs units from two services. Overall command lies with the Airbase or Station Commander. An Army unit and a Field Squadron of the Royal Engineers forms the core of the ADR force and has its own Commanding Officer who becomes the Station Commander’s ADR Commander.

The tactical headquarters of the ADR Squadron forms an ADR cell that is co-located with the Air Operations Staff in the Airbase Operations Centre (ABOC). Through his Tactical Headquarters, and by radio when he is out of the ABOC, the commander of the ADR force is in direct contact with the station commander.

At lower level communications in the ADR unit, radio is required at two levels:

- From the Tactical headquarters to the various elements of the ADR force, whether they be Reconnaissance elements, EOD teams, Crater Repair Teams or whatever.
- Within the various teams to control individual machines.

Once the command structure is right, ADR is then largely a matter of well trained servicemen with the right equipment, the appropriate Standing Operating Procedures (SOPs), and proper drills that are understood and practised by everyone on the airbase. Figure 2 shows the personnel and equipment required to form an ADR unit. The elements of the unit are grouped into functional teams. The number of teams of various types will depend on the threat and the resources available. The level of command will reflect the span of responsibility.

Success in wartime depends upon the supply of special equipment and training in peacetime, whilst some items needed for ADR may have useful roles in routine airbase maintenance, suitability for its war role must be the key selection criteria.
SECTION 4
HOW TO DETERMINE THE SCALE OF ADR PROVISION

1. Assess Threat

Different countries face different threats of attack, ADR is concerned with an assessment of the likely damage resulting from the enemy attacking your airfields. The requirement is to keep the airfields open for four types of operation:
- Generation of Air Defence assets
- Interdiction of invading forces
- Suppression of enemy airfields, missile launchers and radars
- The landing, turnaround and take-off of heavy transport aircraft bringing in support from friendly countries.

The requirement entails maintaining Aircraft Operating Surfaces of sufficient quality and strength to allow the priority operations to proceed with the minimum of delay and disruption.

The ADR requirement can be derived in one of two ways; firstly from the threat assessment made by the Air Staff. In making this assessment the Air Staff consider many factors, the most important are:
- The enemy’s capability
- The requirements of your own air command
- Own active defences
- The passive defences on own airbases
- Redundancy

This is not a precise exercise, but it does highlight gaps in knowledge, which are important to identify when the inevitable assumptions have to be made.

2. Assess Capability

The second method of determining the scale of ADR provision is to make it ‘capability based’. To provide a package of equipment and materials together with the trained manpower which is well balanced and able in a given situation to complete a specific number and type or repairs in a given timescale.

This translates into definable basic repair teams, it is then a simple matter of deciding how many of each type of team to allocate to any particular airbase.
The sequence of ADR consists of six phases:

1. Reconnaissance
2. Repair Plan
3. Explosive Ordnance Disposal (EOD)
4. Rapid Runway Repair
5. Restoration of Essential Services
6. Repair of Lower Priority Damage

However in practice this process is interrelated and in many cases interdependent.

Figure 1 - Airfield after Attack
1. **Reconnaissance**

Immediately after an attack, the base commander must:

- Establish what damage has occurred
- Identify which must be dealt with before flying can be resumed.

Damage that does not affect the ability of the base to fly does not matter at this stage. A joint reconnaissance by elements of airbase units and the ADR force is essential; but in the era of area denial munitions, ground reconnaissance is likely to be slow and hazardous.

2. **Repair Plan**

Plans should be made to provide heliborne reconnaissance, which will overcome many of the problems of ground reconnaissance.

The helicopter ideally needs to be equipped with low light/infra-red TV cameras in order to pass real-time information back to the ADR cell in the ABOC. Appropriate plotting techniques hard copy can
then be produced in real time to assist the ADR Commander advise the Station Commander on the options available.

Once the decision has been made, the ADR commander must make his repair plan to implement the decisions of the Station Commander. He must then issue the necessary orders to the various Repair Teams.

3. Explosive Ordnance Disposal (EOD)
EOD is a major problem. Unexploded bombs arise from 3 causes:

• The need to de-arm damaged aircraft
• 10% of fuses (or more) malfunction
• Many weapons will be deliberately fused with anti-handling, time-delay, or other multi-function fuses that hinder airfield repair

The scale of the EOD capability to be provided is defined by the Air Staff as part of their threat Assessment of damage likely to occur. In general terms, the numbers of Unexploded Ordnance (UXO) will increase as their size decreases.

There are three basic methods of EOD:

• Destruction by detonation
• Neutralising by dismantling
• Rapid disruption without detonation

The method selected will depend upon the size of the bombs, the quantity and the manpower and expertise available.

4. Rapid Runway Repair
After having inspected what is damaged, identified what must be repaired and started dealing with the un-exploded bombs, the actual repairs to the airfield pavement can now be started.

The first essential is to repair those areas that are to form the MOS (Minimum Operating Strip). No matter what else may require repair on the base, fixed wing flying cannot be resumed until the MOS and access to it are available.

The MOS is simply an area of airfield pavement suitable for use as an emergency runway. Dimensions for the MOS will be laid down by the Base Commander in the prevailing circumstances. The ADR force must clear all the debris from the MOS and repair the damage to it.
The damage is likely to consist of a combination of scabs and craters:

**Scabs**
Scabs are defined as damage that does not penetrate the airfield pavement; they may be up to 1 metre in diameter and are caused by rockets, cannon fire, bomblets or bouncing bombs. Scabs are likely to be present in large numbers.

The sheer quantity of scabs to repair (potentially two or three hundred) in a short period of time is the challenge to be faced. Locating them and identifying those that have to be repaired so as not to spend resources on non-essential repairs, requires careful control.

**Craters**
Craters are damage, which not only destroys an area of pavement, but also disturbs or destroys the sub-base.

Crater repair is more complex. Ejecta is thrown out and also falls back. The heave round the crater rim must be removed or levelled, together with a ruptured zone, which may have to be dug out.

Also to be noted, because of the ruptured zone, the true diameter and depth are much greater than the apparent diameter. Thus the repair task is much greater than an initial inspection might indicate.

It would require some 40 x 20 tonne loads of stone to fill the hole, if the original ‘clean bowl’ repair technique were used.

A crater repair consists in essence of refilling the crater bowl, reducing or removing the heaved pavement, and providing a strong structural capping to the filled crater. There are two successful techniques for crater filling, these are called ‘clean bowl’ the original technique, and the more recently developed and improved ‘dynamic compaction’ technique.

**‘Clean Bowl’ Technique**
As its name implies, consists of removing the ejecta with wheeled loaders and pulling back the heaved pavement with heavy-wheeled excavators. The resulting cleaned out crater is filled with a single sized stone, which behaves like a bag of marbles and is incompressible.

The top layer of graded stone is then placed on top of the single sized stone. This top layer is levelled with a specially designed screed beam and compacted with a self-propelled 10 ton vibrating roller. The fill material is brought to the crater site from pre positioned stock piles by a fleet of either 20 ton tippers or frame steer dump trucks fitted with DROPS system skip body.
THE PROCESS OF AIRFIELD DAMAGE REPAIR (ADR)

Figure 4 - Removing the Ejecta

Figure 5 - Removing the Ejecta
SECTION 5 - Crater Repair: Clean Bowl Technique

Figure 6 - Fill with Course Aggregate

Figure 7 - Manual Levelling of Course Aggregate
THE PROCESS OF AIRFIELD DAMAGE REPAIR (ADR)

Figure 8 - Fill with Fine Aggregate

Figure 9 - Levelling of Fine Aggregate
SECTION 5 - Crater Repair: Clean Bowl Technique

Figure 10 - Mechanical Levelling of Aggregate

Figure 11 - Crater Filled and Levelled
‘Dynamic Compaction’ Technique

The procedure is quite different from the clean bowl technique, in that all the ejected material is pushed back into the crater supplemented if necessary by a small quantity of stone from the stockpiles to form a hump or surcharge. This backfill material is then massively compacted using a seven tonne dynamic compactor to ensure deep compaction.

The dynamic compactor is hydraulically activated and mounted on a super-heavy wheeled loader.

Delivering up to 30 blows per minute and mounted on a fast, highly manoeuvrable base machine, dynamic compaction achieves the most dramatic saving in the requirement for repair material, men and equipment. In addition the dynamic compactor is in most cases able to reduce the heave by ‘gently’ tamping the heaved pavement back to its original level, thus reducing the overall size of the repair task by upto 50%. This saves time, materials and manpower.

Comparison of the two techniques:

• Dynamic compaction needs less heavy equipment and hence fewer men than that clean bowl.
• Dynamic compaction in re-using the crater material requires the stockpiling of smaller quantities of fill material, and as less material needs to be hauled to the crater repair, fewer dump trucks or tippers are required, hence fewer drivers, again a further saving in time, cost and manpower.
• By reducing or flattening the heaved periphery of the crater, dynamic compaction ensures, not only a repair requiring the minimum area of surface capping, a further saving in time, manpower and cost.
• Dynamic compaction produces a better-compacted and more stable crater filling, which is of great importance where heavy aircraft may have to transit the repair.
• Clean bowl though expensive in equipment, manpower and material usage, has in-built flexibility and is of universal application. Ideally, it is desirable to have the resources to adopt both methods.
SECTION 5 - Crater Repair: Dynamic Compaction Technique

Figure 12 - A typical crater from a 500kg bomb
THE PROCESS OF AIRFIELD DAMAGE REPAIR (ADR)

Figure 13 - Force Ejecta back into Crater

Figure 14 - Force Ejecta back into Crater

Selected Fill

Fallback

Rupture Zone
SECTION 5 - Crater Repair: Dynamic Compaction Technique

Figure 15 - Check the Heave

Figure 16 - Dynamic Compaction

Figure 17 - Dynamic Compaction

Figure 18 - Compacted Crater
THE PROCESS OF AIRFIELD DAMAGE REPAIR (ADR)

IMPORTED WELL GRADED AGGREGATE
450mm Max Screeded Depth

Figure 19 - Bulk Fill & Screed

Figure 20 -Bulk Fill with Aggregate

Figure 21 - Screed

Figure 22 - Check the Screed Level

COMPACTED FILL
SECTION 5 - Crater Capping: Bomb Damage Repair Mats

Crater Capping
A reliable surface for the repaired crater bowl must be provided. There are two viable capping options for the successful repair of aircraft operating surfaces within the context of ADR.

Aircraft undercarriages impose very high point loading on airfield pavements, it is therefore essential that the runway surfacing has a high degree of inherent strength and structural integrity, to distribute these loads to the underlying repair. This of course is particularly important where the repair may be required to carry high pressure wheels of modern combat aircraft or very heavy transport aircraft.

Those two options are:
• Bomb Damage Repair Mats
• Flush Capping

Bomb Damage Repair Mats
The simplest, surest, quickest and most effective capping is the ‘matting overlay’ when used in appropriate circumstances. Bomb Damage Repair Mats (BDRM) can be pre-assembled and stored in the airbase, virtually forever if need be. Each mat measures 22m x 16m and weighs 13,000kg. The mat is edged with side fairing panels to ensure smooth transition on and off the mat.

The same interlocking heavy-duty aluminium planks can be assembled into smaller patches as required. When needed in war after an attack:
• The mat is picked up by its self-loading trailer for delivery to the crater site
• Once unrolled over the compacted and screeded crater
• The mat is tensioned, and bolted down to firm pavement
• After a sweep to remove potential FOD hazards, the mat is ready to be trafficked immediately by combat aircraft

The FAUN Bomb Damage Repair Mat (BDRM) was specifically developed to meet the requirements of a simple, fast, reliable, high quality crater capping system. Since development, it has been adopted by the UK MOD and other NATO nations. Those nations that did not adopt it either adapted obsolescent steel matting of WWII vintage (PSP) or aluminium matting developed for expeditionary force airfields and already held in their inventories (in particular – AM2). The UK holds considerable stocks of AM2 matting for “out of area” forward airfield construction, but determined several
THE PROCESS OF AIRFIELD DAMAGE REPAIR (ADR)

Figure 23 - Roller to Level

Figure 24 - Mechanical Roller to Flatten

Figure 25 - Lay BDRM

Figure 26 - Transport BRDM to Site using specialist Trailer

COMPACTED MATERIAL

BDRM/P

COMPACTED FILL
SECTION 5 - Crater Capping: Bomb Damage Repair Mats

Figure 27 - Unload and Position BDRM

Figure 28 - Roll Out BDRM

Figure 29 - Unload and Position BDRM

Figure 30 - BDRM after many Sorties
Figure 31 - Jaguar take off on BDRM
years ago that AM2 does not meet the criteria demanded by the air staff for ADR. In particular it cannot be stored in its assembled form, so that both time and manpower are needed to assemble AM2 at the crater site during the repair.

The FAUN BDRM arrives on site completely pre-assembled (including end fairings) carried in a roll on its own self loading/unloading trailer. It is quickly and simply unrolled and bolted down over the filled crater. Speed is of the essence, and with the latest techniques, manpower requirements to lay the mat are much reduced.

The FAUN BDRM can be easily joined, separated or redeployed if required, whereas, with other mat systems, such adaptations are at best laborious, or at worst nearly impossible in the context of ADR.

With its flexibility of use, BDRM can provide an immediate solution in a number of emergency situations both on and off the airbase, (crash access, expedient prefabricated taxitrack, additional hardstandings etc). Once provisioned, the mat will be available for decades, held ready for use without special storage conditions.

Flush Capping
The crater bowl is filled using the dynamic compaction method, to within 250mm of the runway surface.

- If necessary the bulk fill in the crater bowl is blinded with a thick sand layer to seal the surface to prevent grout loss.
- A self-propelled vibrating roller and a small plate vibrator are used to compact this blinding into the bulk fill.

- The remaining top 200mm (approx.) of the crater is then filled with a single sized, nominal 18mm aggregate.
- The aggregate is screeded level and firmed up with a single pass of the roller.
- The top capping layer is flooded with the grout mixture; using gravity flow directly from purpose built Croker RP 1500 grout mixer.
- The ASR 1 grout is designed with special flow characteristics which allow it to percolate through the voids in the 18mm stone layer until the whole area of the repair is flooded to surface.

Flush Capping Equipment & Material
- In crater repair the quantities of material used are quite considerable.
- The quantities of grout powder and water needed also demand
that adequate provision be made.

• At least 10 tonnes of clean water and 50 tonnes of special grout powder is required.

• The disadvantage of this method is the short timeframe in which the grout powder must be used. Grout powder has a very short shelf life – it must be kept dry at all times and disposed of and replaced if not used.

Evaluation of Crater Repair

• It is vital to have a rapid crater repair capability; it is a task of some magnitude requiring the provision of significant quantity of specialist equipment and materials, well before hostilities begin.

• Dynamic compaction greatly reduces the resources required.

• BDRM gives a flexible, reliable solution in many situations that is not materials intensive.

• Time of repair is of high importance.

5. Restoration of Essential Services (RES)

The restoration of essential services is an aspect of ADR that tends to be overlooked.

"...attacking runways is not necessarily a high pay off activity when the other guy knows how to fix them. If you go to an airfield, you want to hit other things as well; the pump for the fuel manifolds, the power supplies, the water supplies (or the dining hall at lunch time)...."

General Dugan, former Chief of Staff USAF, speaking in 1993 about the lessons of the Gulf War

Note that in the UK, restoration, not repair, is the key word, as replacement is usually quicker than repair. For example, it will often be easier to install a bypass to a damaged pipeline than excavate and repair the old one, particularly if the system has been designed or modified with that in mind. This is an example where three facets of ‘survivability’ are closely interwoven – protection – dispersion and ADR.

Much of the provision of an effective system for RES should be part of the basic airfield design and layout. If not, an essential services audit must be carried out to determine what works are necessary to achieve the required level of duplication and flexibility in operating the various utilities on the base.

Only essential services (those that must be restored before flying can
be resumed) matter. It is vital that records of airfield services are updated continuously, contingency plans maintained and stocks of items essential for the maintenance of utilities be included in the war plans for the base.

Stand-by power equipment is the most obvious requirement. Distribution will require the repair of damaged cables. Similar kits should be held to repair water and fuel pipelines. For emergency use, temporary bulk fuel installations can be constructed on or near the base, probably with the ability to tap into the base supply pipelines.

6. Follow on Repairs
Follow on repairs is the final phase of ADR. The airbase must be prepared to withstand repeated attacks. If further repair work is not continued once aircraft are flying again, the enemy will have an increasingly simpler task to close the airbase again in their subsequent attacks. The cumulative effect can soon bring a base to an irrecoverable situation, while the synergistic effects of uncleared area denial munitions combined with ever increasing debris can make the base untenable.
All armed forces are national insurance policies, if the huge investment made in air assets is to be available in an emergency, then they in turn must be protected by an ADR capability. Since modern wars start with the pre-emptive air strike, the ADR capability must be in place in peacetime and available at very short notice. Fortunately, like any good insurance, the cost of the ADR capability is trivial in relation to the assets it safeguards.

The Air Staff are responsible for ADR. They make the threat assessment and develop the operational requirement. They allocate the resources to implement the capability. They issue the orders for effective integrated training and they set the standards required, ADR is an essential part of survivability, not some sort of support function.

Appendix 1 one shows a typical equipment list for ADR. In addition to their initial capital cost, the introduction of the ADR equipment will inevitably bring on-going maintenance costs. Such costs will depend largely on the rate of use of the equipment; at typical use rates, maintenance costs may be expected to be in the order of 3 - 5% of capital cost per annum. With proper care and maintenance, the heavy military plant that is required for ADR may be expected to have service life of 15 – 25 years in peacetime. The introduction of items, selected from those that have proved themselves to be fit for service in the UK, will be a cost effective way to introduce a vital capability into any service quickly.

A nation must select the options available to meet their own needs and within their resources. There never has been and never will be a single right solution. What is required is a balance of trained men and the right equipment. The right equipment will certainly contain devices and skills to use more than one technical solution.

Finally the base commander is responsible for the efficiency and training of his ADR force in just the same way as he is responsible for all the operational aspects of his base. Training is at three levels; individual skills, the collective skills of the ADR force and the integrated operation of the whole base when under attack. The runway of a modern airbase is part of the front line of modern airwarfare.
**APPENDIX 1:** Typical Timings for the Repair of a Medium Size Crater

<table>
<thead>
<tr>
<th>Serial Number</th>
<th>Activity</th>
<th>Time in Minutes</th>
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<tbody>
<tr>
<td>1</td>
<td>Deploy to site</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Set up Floodlights</td>
<td>0, 5, 10</td>
</tr>
<tr>
<td>3</td>
<td>Clear Debris</td>
<td>15, 30, 45, 60</td>
</tr>
<tr>
<td>4</td>
<td>Cut out Heave</td>
<td>20, 35</td>
</tr>
<tr>
<td>5</td>
<td>Clean Crater</td>
<td>40, 55</td>
</tr>
<tr>
<td>6</td>
<td>Fill Crater</td>
<td>60, 75</td>
</tr>
<tr>
<td>7</td>
<td>Level &amp; Compact Aggregate</td>
<td>80, 90</td>
</tr>
<tr>
<td>8</td>
<td>Screed Surface</td>
<td>105</td>
</tr>
<tr>
<td>9</td>
<td>Lay, tension &amp; boltdown Mat</td>
<td>110, 115, 120</td>
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<tr>
<td>10</td>
<td>Sweep Area</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Scab Repair</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Clear Area</td>
<td></td>
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</tbody>
</table>
APPENDIX 2: Airfield Damage Repair Unit Diagram

AIRFIELD DAMAGE REPAIR (ADR)

HEAD QUARTERS
- COMMAND & CONTROL
- ADMIN SUPPORT
- LIGHT VEHICLES (3/4 T)
- RADIO EQUIPMENT
- ADR TRACTOR WITH DEMOLITION BUCKET
- FLAIL CLEARANCE UNITS
- GRADERS
- WHEELED EOD ROBOT VEHICLES
- VEHICLE MOUNTED EOD EQUIPMENT
- WATER BOWSERS
- PAVEMENT SWEEPERS

EOD
- EOD TEAMS
- CLEARANCE TEAMS
- LIGHT VEHICLES (3/4 T)
- MEDIUM VEHICLES
- ADT TRACTOR
- MEDIUM WHEELED TRACTORS
- HEAVY WHEELED EXCAVATORS
- LIGHTING SET TRAILER
- PUMP SET TRAILER
- SELF PROPELLED VIBRATING ROLLER
- SCREED BEAM & TRAILER
- GENERATOR SET
- BDRM TENSIONING KIT
- BDRM BOLT DOWN KIT
- GROUT MIXER
- RRR KIT
- PLATE COMPACTOR
- PAVEMENT SWEEPER

CRATER REPAIR
- CRATER REPAIR TEAMS
- LIGHT VEHICLES (3/4 T)
- MEDIUM VEHICLES
- LIGHTING SET TRAILER MOUNTED
- SCAB REPAIR KITS

SCAB REPAIR
- SCAB REPAIR TEAMS
- LIGHT VEHICLES (3/4 T)
- MEDIUM VEHICLES
- SCAB REPAIR CEMENT

RESOURCES
- MATERIALS DELIVERY TEAMS
- LIGHT VEHICLES (3/4 T)
- MEDIUM VEHICLES (4 T)
- HEAVY SHOVEL LOADERS
- MEDIUM DUMP TRUCKS MOUNTED
- BDRM TRAILERS
- ROUGH TERRAIN FORK LIFT TRUCKS
- WATER BOWSERS
- BDRM MATS
- BDRM ASSEMBLY KIT
- BDRM SIDE FAIRING KITS
- FLOOD GROUT CEMENT
- SCAB REPAIR CEMENT
- STONE STOCKPILES