



# The Military Perspective on Power & Energy

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# Dstl's Role in MoD

- An agency of MoD
- Dstl provides technical advice
  - on research programme formulation
  - monitoring, assessment and integration of knowledge
- Dstl provides services & connectivity
  - research that must be within government
  - access to external information sources
- Dstl assists in S&T management process
  - helping to set strategic direction
  - provision of S&T knowledge management services

# Dstl Power Sources Function

- Largely advice based
  - technology watch
  - programme monitoring
  - assessment
- Focus on electrical power sources
  - e.g. fuel cells, batteries, etc
- International partnership
  - US, Canada, Germany, etc
- Current research
  - carbon-air battery (with St Andrews University)
  - borohydride fuel cell (US Office of Naval Research)
  - submarine power system modelling
  - energy harvesting



250W sodium borohydride fuel cell stack, developed for underwater application



Carbon-air cell

# MoD Operational Context

## Expeditionary operations



Remote theatres of operation mean there's no power supply – power sources must be carried (left). Delivery deep into the battlespace is costly and hazardous (right).

## Joint operations



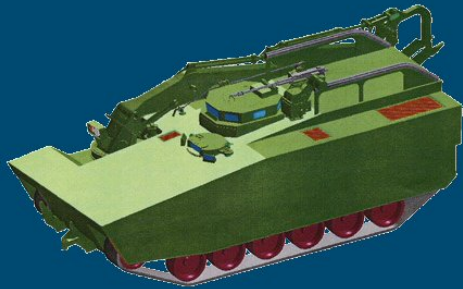
Joint warfighting puts a premium on interoperability. Here a UK Tornado refuels from a US KC-10 tanker.

## Extreme conditions



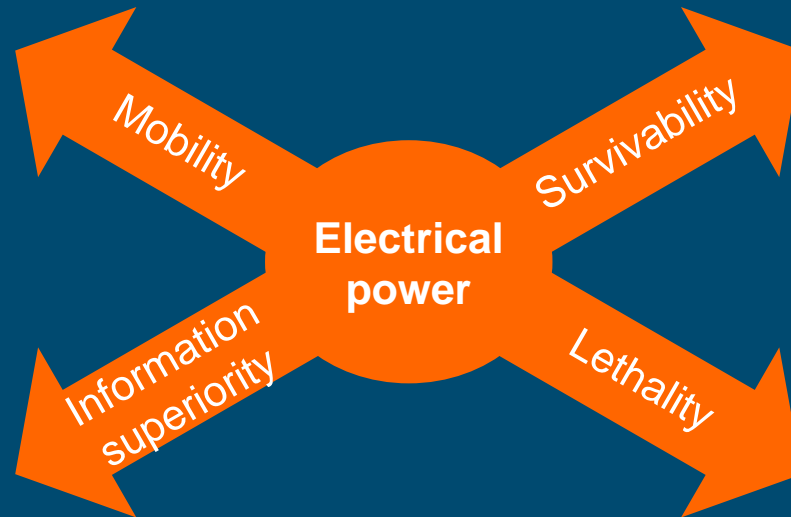
Military kit must be able to tolerate hot & dusty conditions e.g. Iraq (left). The Afghanistan mountains present a different challenge (right)

# Top Level Requirements



Variant of Future Rapid Effects system. Hybrid electric drives are an option for the future

Power and energy sources are a means to an end ...



Electric armour test against rocket propelled grenades



Zephyr high altitude long endurance unmanned air vehicle

... they enable defence capabilities

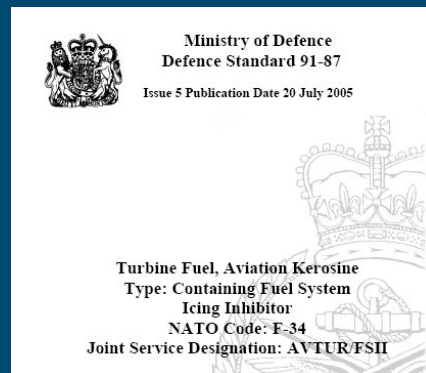


90mm electromagnetic gun test firing

# Energy Sources (1)

- For large energy demand mainstream applications, liquid hydrocarbon fuels are mandated
- MoD is not a large user of fuel (relatively speaking)
  - cannot lead on future fuels
- Door is partially open for synthetic fuels

UK defence standard for jet fuel allows for blending synthetic fuels up to 50%



Operability on NATO single fuel is required for ground based equipment



Royal Navy requires high flashpoint fuels such as F-76



Thermal stability required for fast jet application – with higher flashpoint jet fuel variants for carrier borne aircraft



## Energy Sources (2)

- For niche applications or where overall energy requirement is relatively low, unusual energy sources are possible
- Batteries used extensively
  - platform energy storage
  - dismounted application
- Packaged fuels such as methanol could be acceptable
  - conceptually similar to batteries
  - similar logistics issues
  - could be used in dismounted applications



No other option provides the endurance of a nuclear reactor for submarine power

# Power Source Requirements

- Power source requirements are complex and peculiar to the application
  - Generally power source will be mobile
    - located on weight and/or space-constrained platform
    - portable
    - transportable
  - Frequent themes
    - longer endurance
    - higher power
    - lower weight/volume
    - higher efficiency
    - safer, more reliable, rugged
    - low maintenance
    - stealth
    - integration
- Pushing the limits of energy storage density and power density**
- Lower through life and logistics costs**
- Benefits of more-electric and all-electric platforms**
- Desire to reduce fuel usage**



# Case Study – the Dismounted Soldier

- Heavy physical load
- Up to 25% of overall weight carried can be batteries
- Electrical demand
  - communications
  - navigation
  - targeting
  - sensing
- Main current usage is primary AA cells and larger rechargeable batteries



The dismounted soldier shoulders a heavy burden

# Future Soldier Technology

- Near term potential loads
  - personal role radio (data)
  - radio
  - GPS, navigation system, situational awareness computer
  - image intensifying sight
  - thermal sight & head-up display
- Medium term
  - chemical/biological agent sensors
- Long term possibilities
  - micro-climate control systems
  - exoskeletons
  - energy weapons



MoD is currently militarising and optimising for UK requirements a reformed methanol fuel cell for evaluation as a potential central power source for soldier kit

# Energy Systems/Materials Requirements

- Increased energy density secondary batteries
  - new chemistries, improved safety, etc
- Fuel cells operable on military fuels
  - e.g. sulphur-tolerant materials
  - durable catalysts
  - direct oxidation materials
- More rugged power sources
  - e.g. air contaminant tolerance
- Improved energy harvesting materials
  - e.g. higher ZT thermoelectrics
- Multifunctional materials
  - e.g. stiff and light electrode materials

# MoD Initiatives/Opportunities

- Centre for Defence Enterprise
  - gateway for disruptive/innovative proposals
- Defence Technology Centres
  - MoD/academia/industry partnerships
  - SEAS DTC has a power strand
- Counter-Terrorism Centre
  - open to new partnerships
- High Impact Rapid Implementation Demonstrator Programme (HIRID)
  - high risk, high payoff technologies
  - portable power is one of the pilot themes
- Joint Academic Research Defence Programme
  - joint MoD/research council funding
  - Dstl good first point of contact
- Equipment programme contracts

[www.science.mod.uk](http://www.science.mod.uk)

[www.ctcentre.mod.uk](http://www.ctcentre.mod.uk)

[www.contracts.mod.uk](http://www.contracts.mod.uk)



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