

CRESSALL



INDUSTRIAL POWER RESISTORS



NEUTRAL EARTHING

DYNAMIC BRAKING

LOAD BANKS

RENEWABLE ENERGY

HARMONIC FILTERS

MOTOR CONTROL

EV BRAKING



A photograph of a renewable energy site. In the foreground, several rows of dark blue solar panels are tilted towards the sun. In the background, a tall white wind turbine stands against a clear blue sky with scattered white clouds. The overall scene represents clean, sustainable energy.

**WHY SPECIFY
GRESSALL
RESISTORS?**

Cressall built their first resistors in 1912 and, though we go back a long way, we've always been in the forefront of resistor design and development.

From trams to high speed trains, stationary engines to nuclear power stations or warships to wind turbines we are proud to have provided industry with the resistors they need for over a hundred years. Our unrivalled experience translates into the most comprehensive resistor range in the world, using more technologies and resistor types than any other manufacturer. This means we can not only meet current needs but also anticipate future resistor requirements and provide the solutions necessary.

The designers and engineers at Cressall have been responsible for many of the important breakthroughs in resistor development including the revolutionary EV2 modular ceramic braking resistor described in this brochure.

Cressall have achieved their unequalled reputation by the quality of their products and the continual investment in design and manufacturing processes at their two UK factories. We operate both Quality Management System to ISO 9001:2015 and the standard for occupational health and safety management, ISO 45001:2018 across our main location in Leicester and our Transit and Special Projects division at Dereham. Both sites also have in place Environmental Management Systems based on but not approved to ISO14001:2004.

All this makes Cressall the ideal partner for your next project - big or small.



WHY SPECIFY CRESSALL

Cressall reliability

Cressall products are well-proven in the most arduous and demanding environments such as those found in steel works, chemical plants and oil rigs.

Versatile technology

The broad range of Cressall resistor elements provides the versatility required to offer solutions for any application.

Resistors can be specified for any combination of resistance value, temperature rise, duty cycle, current and voltage rating.

Product development and innovation

Cressall's range of resistor elements are subject to a process of continuous research, development and product innovation.

Recent developments include:

- Launch of a range of water-cooled braking resistors for marine use.
- Portable load bank range extended to 500kW AC units.
- Investment into our versatile mesh resistor range.

Fast response

Whatever your resistor requirements our team of qualified engineers and production staff will offer a fast, cost-effective solution and deliver a service that is second to none.

This commitment extends through every stage of the process, from initial enquiry to after-sales support.



Quality Control

Cressall Resistors operates a Quality Management System approved to ISO 9001:2015 at both the main location in Leicester and the Transit and Special Projects division at Dereham. Both sites operate an Environmental Management System based on, but not approved to the requirements of ISO14001:2004

Cressall operates a Health and Safety Management System approved to ISO 45001:2018, the internationally applied standard for occupational health and safety management systems.

Environmental Policy

Cressall recognises its responsibility to meet the requirements of its customers without unnecessary damage to the environment. This includes REACH Regulation 1907/2006 relating to the protection of human health and the environment.

Health & Safety

Cressall is firmly committed to the welfare of its employees, customers and community. We manage all of our activities to identify all applicable hazards and we promote continual improvement based on both assessing the risks posed and the procedures documented within the system.



RESISTORS?



NEUTRAL

Cressall neutral earthing resistors (NERs) are employed in AC distribution networks to limit the current that would flow through the neutral point of a transformer or generator in the event of an earth fault.

The rating of an NER is chosen to meet the requirements of the system protection scheme; this will include consideration of maximum acceptable fault current, earth potential levels, and preventing damage caused by the fault.

11kV rated NER/NGR with HDG mild steel enclosure, unit includes separate HV and LV cable boxes and additional panels to restrict accidental contact with hot surfaces.



EARTHING

CRESSALL NERS HAVE NUMEROUS BENEFITS:

Choice

An extensive range of metal resistor elements allows selection of the most efficient and cost effective solution for any required duty. Cressall can manufacture NERs for any system voltage and initial current with rated times from a few seconds to continuous.

Stability and predictability

The resistance value is set at the manufacturing stage and remains constant throughout the life of the NER. Unlike liquid resistors, changes in resistance value due to the fluctuations in ambient temperature are negligible. This means that protection levels can be accurately pre-determined.

In contrast to an earthing reactor, a Cressall NER does not induce phase changes or resonances into the fault current and does not require matching to the associated transformer.

Rapid cooling and short time ratings

Modern protection systems typically clear faults in less than a second. However, the time rating of an NER usually needs to cater for the possibility of several successive faults.

Cressall resistors cool down much faster than liquid resistors after operation. To cater for successive faults liquid resistors have longer time ratings, typically 30 seconds, as opposed to 10 seconds for metallic resistors.

Ease of installation

Cressall NERs are compact and do not require site calibration or auxiliary power supplies.

Low operating costs

Fixed resistance values mean that maintenance is limited to periodic inspection and cleaning. Anti-frost and anti-condensation heaters are not generally required.

Reliability

NERs may only be called upon to operate a few times in their service life, which may be 25 years or more. Cressall NERs have been proven reliable in numerous installations and under severe climatic conditions world-wide.



NEUTRAL

CONSTRUCTION

Standards

Currently there are two International standards for Neutral Earthing Resistors, ANSI/IEEE C57-32a and the recently released BS EN IEC 60076-25:2023, Cressall NERs can be designed and tested to either standard or to individual client specifications.

Resistor elements

For the majority of ratings the most suitable element type is the RP oval edge-wound coil.

RP resistors are manufactured from a continuous stainless steel strip, wound edgewise into oval coils. Each coil is supported by ridged ceramic insulators mounted on a stainless steel centre support, with stainless steel terminals welded at each end. This arrangement allows free expansion and contraction at operating temperatures up to 1100°C without imposing strain on the assembly.

The resistance alloys used are high temperature stainless steels capable of withstanding temperature excursions to 1100°C whilst retaining their strength, unlike 304 or other structural grade stainless steels which are limited to much lower temperatures.

NERs designed for operation at higher temperatures require less active mass, resulting in more compact and economical designs.

Temperature coefficient of resistance

Unlike structural grade stainless steels the temperature coefficient of the material used ensures a resistance increase of less than 3.5% per 100°C rise over the operating temperature range.

Resistor banks

The end insulators of individual resistor elements are clamped and locked on to tie-rods. Any

element can be removed without disturbing the remainder.

The tie-rods are supported between galvanised end-plates to form banks. These banks can be mounted on top of each other with intermediate insulators to form a complete self-supporting stack.

Interconnections between coils are copper, using two bolts per joint.

Enclosure protection ratings

The standard enclosure is designed to IP23 to IEC529 (to prevent the ingress of foreign bodies greater than 12mm, and rain falling at any angle up to 60° from the vertical). This rating is suitable for indoor or outdoor use as it allows sufficient cooling and provides more than adequate protection unless the environmental conditions are extreme. Protection ratings above IP23 are rarely needed because Cressall resistor stacks are virtually corrosion proof and immune from progressive pitting and rusting. The operation of the resistor and the ceramic insulators are not affected by exposure to condensation, sand or fine dust, provided that the dust is not unduly conductive.

If higher degrees of protection are specified, these can be provided (up to IP55). It should be realised that the operational penalty of using less well ventilated enclosures is that the external surfaces will become hotter and cooling times will be longer.

Enclosure materials and finish

Enclosures are manufactured as standard from unpainted stainless steel. This ensures better and more economic long term corrosion protection than galvanised or painted mild steel units.

If required other enclosure materials and special finishes can be supplied to comply with users' specifications.

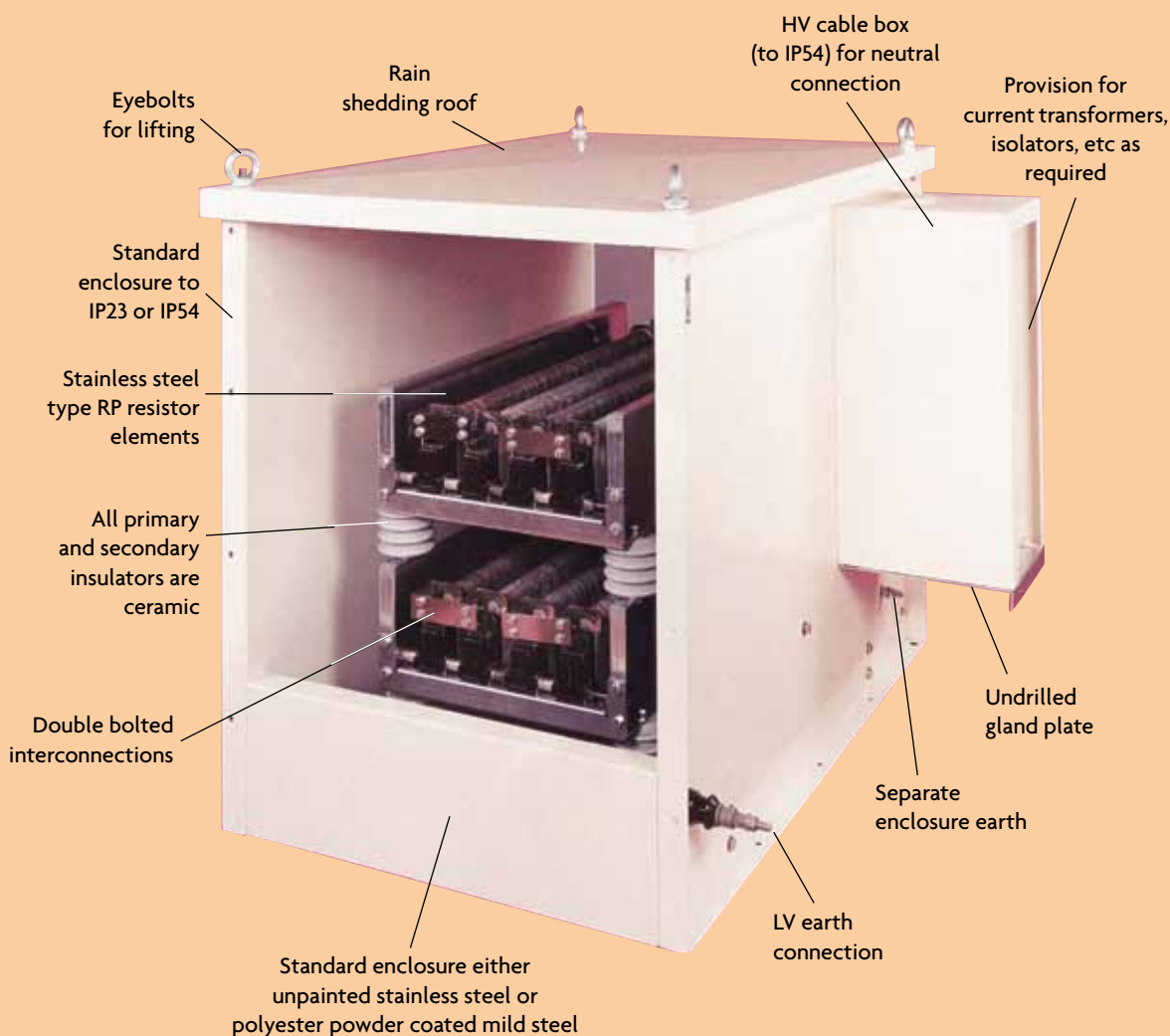
EARTHING

Electrical connections

As standard a HV bushing is mounted on the side of the enclosure. The bushing is housed in an air insulated bottom-entry cable box with a removable undrilled gland plate.

A low voltage bushing is provided for the resistor earth connection. Where required this can also be enclosed in a cable box. Earthing of the enclosure is via two separate stud type terminals, fitted diagonally opposite each other.

As an alternative to the cable boxes, bushings can be mounted on the top cover. However, the enclosure should then be mounted on a plinth or structure to raise the height of the bushing to a suitable distance above ground level to avoid accidental contact. Suitable steel plinths can be supplied.



NEUTRAL

Other equipment

Where required cable boxes can house current transformers, isolators, vacuum contactors or other ancillary equipment.

Standard tests

NERs can be tested to either ANSI/IEEE C57-32a or to BS EN IEC 60076-25:2023 as agreed with the customer.

Routine tests on all units include:

- Dimensional check to relevant drawing
- Resistance measurement at ambient temperature
- Insulation resistance measurement
- One minute power frequency withstand test

Temperature rise tests have been carried out on a range of typical ratings. Copies of these results are available.



Transformer mounted NER rated
11kV, 1000A for 10 seconds.



EARTHING

MULTI CONTACTOR NERS



Vacuum Contactors

For medium-voltage power generating schemes which have multiple diesel generating sets, it is necessary to ensure that one (and only one, to avoid the possibility of circulating currents) of the neutrals of one of the running generating sets is earthed at all times.

Generator grounding can be economically achieved by using a single earthing resistor of the appropriate rating (usually the full load current on one generator) connected to each of the neutrals with a vacuum contactor which is controlled from the generating set panel.

Standard Range

Cressall offer a standard range of multi-contactor controlled resistors, the range is suitable for most generator voltage, current and time ratings and includes the following features:

- Optional current transformers
- Choice of either top or bottom cable entry
- IP23 or IP54 enclosure designs
- Standard cubicle designs offering up to 9 contactors with one resistor
- Choice of enclosure materials, including painted mild steel, stainless steel or hot dipped galvanised
- Suitable for applications up to 75kV BIL
- Options for auxiliary control voltages
- Options for earth fault relays

DYNAMIC

Cressall is one of the leading suppliers of dynamic braking resistors to OEMs, integrators, users and distributors of AC variable frequency drives.

Cressall DBRs are used to stop motors or to produce a braking torque in the motor during overhauling load conditions. The dynamic braking resistor is connected across the DC bus and can see voltages as high as 1100 volts (Cressall DBRs can be insulated and rated for higher voltages if required).

The resistance value determines the amount of braking torque produced and thus the rate at

which the motor will stop, the lower the resistance the higher the braking torque and the quicker the stop. Drive manufacturers will specify a minimum resistance value to ensure that the braking capacity of the drive is not exceeded. As standard Cressall manufacture DBRs with a $-0/+10\%$ tolerance to ensure optimum performance (other values can be achieved if required).

When sizing brake resistors, key parameters for consideration are resistance value, braking power and the duration and frequency of the stop.

Braking resistors are used for speed control and braking of passenger lifts.



BRAKING

Standard dynamic braking resistors

- **Easily installed**
- **Suitable for all ranges of drives**
- **Suitable for any power or duty cycle**
- **Insulated for operation at 1000V**
- **Optional bi-metallic thermal trip**

To meet the requirements of the market Cressall have developed a range of standard DBRs designed to cater for the most common applications.

Depending on rating these units can be manufactured from stock components.

As standard Cressall DBRs are housed in plated mild steel enclosures affording ingress protection to IP20 or IP21. They include a built-in terminal box, terminal block and high temperature wiring.

A normally closed thermal switch can be offered as an option.



DYNAMIC

ES braking resistors

A comprehensive range of compact, IP20 dynamic braking resistors with a choice of accessories that keeps both purchase and installation costs low - all available at short notice.

- **Rated for repetitive duty**
- **Resistance never lower than expected**
- **Robust construction**
- **Low inductance element**
- **High overload capacity**
- **Close tolerance (+5% - 0%)**
- **Noise free**
- **Temperature stable element**

Cressall ES braking resistors are based on HP Coils, spiral wire-wound on ceramic formers.

These elements have a high overload capacity and cool rapidly. The resistance material is a high grade stainless steel with no more than 7% resistance increase over the whole temperature range. Cheaper designs using 304 stainless steel can increase in resistance during the heating cycle by as much as 50%, which results in lower current and less effective braking.

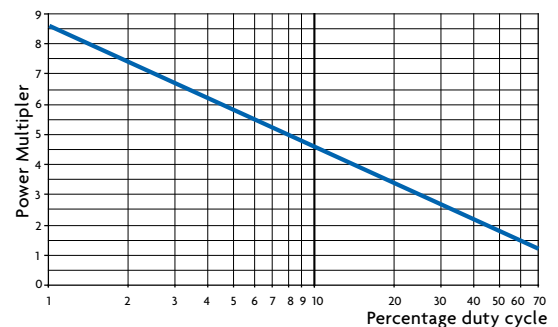
The enclosures are made of galvanized steel. Ingress protection is IP 20.

Options are a thermal switch and/or terminal cover.

Duty cycle and power

The eight standard enclosures have continuous power ratings from 0.6kW to 8kW. These ratings can be exceeded when power is applied for less than 100% of the time. The graph below gives a "power multiplier" based on a 10 second "on time". Multiply the resistor's continuous rating by the "power multiplier" number to calculate power.

Example: 10 seconds on in 100 seconds is defined as a 10% duty cycle. A 10% duty cycle gives a 4.6 times power multiplier. ES1 resistors are rated 1.5kW continuously and so can be rated 6.9kW (4.6 x 1.5kW) for 10 seconds in 100 seconds. If the resistors have a resistance of 100Ω or more, then the power rating is reduced by 20%.



Enclosure	ESH	EST	ES1	EST2	ES2	ES3	ES4	ES8
Continuous power/kW	0.6	1.0	1.5	2.0	3.0	4.5	6.0	8.0
Min □	2.5	4.0	6.0	2.0	3.0	2.0	1.5	0.75
Max □	180	300	450	600	900	1350	1800	3600

Applications

- **Dynamic braking**
- **Motor control**
- **Variable speed drives**
- **Lifts & elevators**
- **Cranes & winches**
- **Conveyors**
- **Test loads**



BRAKING

Maximum operating voltage:

1000V DC or AC rms

Connections

Power: Screw terminals for up to 10mm² cable (ESH-ES3), M8 stud terminals (ES4-8)

Earth: Self taperer, near screw terminals

Thermal sensor: 6.25mm male blade (faston) connections (receptacles not supplied)

Terminal cover (optional for ESH-ES3)

Two 20mm gland holes with cover grommets provided on end face. The cover overhangs the resistor by 22mm. The open overhang area can be used for cable entry.



Thermal sensor (optional)

Located near screw terminals

Normally closed contact, opens at ~250°C, re-closes at ~210°C

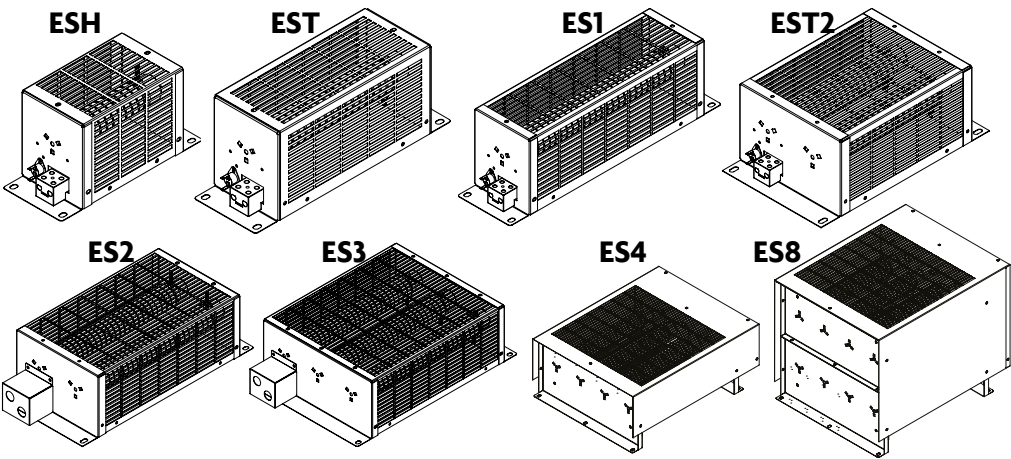
Voltage: 240V AC rms; current: 7A AC rms



Installation

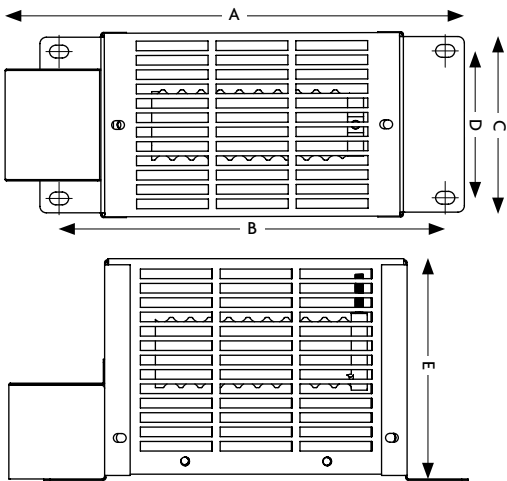
Units have slotted mounting points suitable for M6 fixings. Mount horizontally with base facing down. Other orientations may result in increased element temperatures.

Warning: Units must never be mounted with the terminal area or base uppermost.



Mounting dimensions (mm) and weights

	A	B	C	D	E	kg
ESH	288	236	121	92	141	1.4
EST	367	315	121	92	141	1.8
ES1	467	415	121	92	141	2.2
EST2	367	315	213	185	141	3.0
ES2	467	415	213	185	141	3.8
ES3	467	415	307	278	141	5.4
ES4	500	422	380	352	195	6.6
ES8	500	422	380	352	390	11.5



MARINE BRAK

Electrical drive systems are being used more and more on ships, oil rigs, crane barges and vessels of all types, for every type of powered application: main propellers and bow thrusters, driving winches and windlasses, cranes, lifts, conveyors and jacks, cable laying and tensioning.

Advantages of electric braking

Using an electric drive means that reliable systems of regenerative and dynamic braking can complement or replace traditional mechanical braking systems. The advantages of electric braking include control, reliability, mechanical simplicity, weight saving and the opportunity to make use of the regenerated braking energy making fuel savings when compared with older mechanical systems.

Cressall Resistors' long experience in this field means that we have suitable brake resistor designs for all of the above applications, with braking powers from a few kW up to many MW (needed, for example, for some crane and main propulsion brakes) and cooling methods which include liquid, forced air and natural convection. We have standard products of all types.

Design considerations

Depending on rating many of our designs use elements manufactured from a high grade resistance alloy in sheathed mineral insulated tubes. These are less vulnerable to physical damage, prevent accidental contact with live, possibly high, voltages, and are thus much safer. For heavily polluted areas, or in areas where there is risk of exposure to flammable liquids or gases, or in severely corrosive environments sheathed element would also be used. Marine-grade stainless steel for all metalwork including fasteners and fittings is standard.

For brake resistors operating at more than 1.5kV, sheathed elements are unsuitable and we use live elements. Cooling is usually by natural convection, but if the heat losses after braking would impose unacceptable loads on the ship's air conditioning system we can add an air-to-water heat exchanger to transfer the brake energy to the ship's chilled water system.

WATER COOLED

Fresh water

Most ships have a chilled water system and it is straightforward to incorporate resistors of the type shown into these circuits.

Our standard range uses vessels, cable box and fittings constructed from 316 grade stainless steel.

Sea water

Construction and ratings are as our fresh water designs but with titanium-sheathed elements in higher- grade (super duplex) stainless steel vessels, suitable for continuous duty in hot sea water.



ING



AIR COOLED

Natural convection

For small inverter drives our standard ES range, intended for indoor use and usually incorporated within or on the roof of the drive system control panels. Standard enclosures are in galvanized sheet steel but optionally 304 or 316 grade stainless. For higher powers we have custom-built designs, optionally with air-to-water heat exchangers to dissipate the brake energy via the ship's chilled water system.

Fan cooled

These units are suitable for deck mounting on their included anti-vibration mounts, with enclosures and all fittings and fan in 316 grade stainless steel.



HARMONIC

The ever-increasing use of power electronics has led to a rise in the amount of harmonic voltages on the power supply network. Harmonics can have an adverse impact on many electrical systems and, as such, this makes the aspect of power quality more and more important for both suppliers and users of electrical power.

These harmonic voltages can increase line losses and also have a detrimental effect on other users of the network.

Harmonics can be reduced to acceptable levels by passive filter circuits consisting of inductors, capacitors and resistors. The filter circuit allows through the fundamental frequency and diverts the harmonic frequencies to the resistor bank where they are dissipated as heat and thus lost from the system.

Low inductance is a key design feature of filter resistors. The units offered by Cressall have negligible inductance and are particularly suitable for operation at high voltages in the following applications:

- **Static VAR compensators (SVCs)**
- **HVDC transmission systems**
- **Mechanically switched capacitor damping networks (MSCDNs)**
- **Industrial harmonic filters**

Cressall have supplied resistors for use within filter systems at every level of the electrical distribution system, from 400kV grid transformers to 415V industrial equipment, and with power ratings from a few watts to several megawatts.

Resistors operating as part of an SVC network in an Aluminium Smelting plant in Canada.



FILTERS

Filter resistors operating as part of
an HVDC network in Saudi Arabia



High voltage filter resistors with
snow stands installed in Canada





STANDAR

Cressall has a dedicated division for load banks, Power Prove offering:

- *An extended load bank product range with competitive lead times and pricing*
- *Enhanced features; power measurement, data logging, and remote control*
- *Comprehensive support and product documentation*



AC RANGE

COMPACT, FORCE-COOLED PORTABLE UNITS

Portable load banks for on-site testing of power generation equipment. All units come with manual local control and power indication meters.

Model	Voltage (V AC)	Power (kW)	Steps (kW)	Continuous current (A)	Dimensions L x W x H (mm)	Weight (kg)
AC6-230	220-240 1ph.	6	0.333	27	495 220 415	10
AC6	110-120 1ph.			54	495 220 550	12
	220-240 1ph.	6	0.333	27		
AC30	220-240 1ph.	15	0.333	62	560 400 840	30
	380-415 3ph.	30		41		
AC 100-CPT	230 1ph.	33	2.08	144	579 313 718	38
	400 3ph.	100	6.25	144		



FORCE-COOLED LOAD BANKS WITH DIGITAL CONTROL

All models come with local touch screen control, power metering, data logging and the option to control via a PC or a dedicated remote-control accessory.

Model	Voltage (V AC)	Power (kW)	Steps (kW)	Continuous current (A)	Dimensions L x W x H (mm)	Weight (kg)
AC100	230V 1ph.	33	0.33	144	1067 684 1061	135
	400V 3ph.	100	1.0			
AC200	230V 1ph.	66	1.66	289	1175 806 1370	340
	400V 3ph.	200	5.0			
AC300	230V 1ph.	100	1.66	433	1175 806 1370	400
	400V 3ph.	300	5.0			
AC 500	230V 1ph.	166	8.33	722	1643 1164 1303	560
	400V 3ph.	500	25.0			



DIGITAL CONTROL SYSTEM

Power Proves digital control system, DIGILOAD features:

- Digital power measurement
- Data logging
- Pre-programmable load cycles
- Remote control via PC
- Remote control via dedicated remote-control accessory.

Remote control and cable sets

Dedicated remote control in IP66 rugged case with 10" capacitive touch screen, emergency stop button, USB data download socket.

Cable sets are available in 5m, 15m and 25m lengths and include both Ethernet cable (data) and control cable (remote power and emergency stop signal).

DC LOAD BANKS

DC RANGE

COMPACT, FORCE-COOLED PORTABLE UNITS

All units come with manual local control and test points for external power measurement.

Model type	Voltage (VDC)	Power (kW)	Steps (kW)	Continuous current (A)	Dimensions L x W x H (mm)	Weight (kg)
DC110	28	3.3	fully variable	120	400 200 500	10
DC600/28	28	16.8	fully variable	600	560 400 840	40
DC70	50	3.5	fully variable	70	400 200 500	10
DC220	50	11.0	fully variable	220	560 400 840	15
DC600	50	30.0	fully variable	600	579 313 718	40



DUAL DC/AC 1PH. UNITS

All units come with manual local control, analogue power indication meters and test points for external power measurement.

Model type	Voltage (V DC/AC 1ph.)	Power (kW)	Steps (kW)	Continuous current (A)	Dimensions L x W x H (mm)	Weight (kg)
Dual30 (60/120)	60	31.5	0.5	525	600 500 800	50
	120			262		
Dual30 (120/240)	120	31.5	0.5	262	600 500 800	50
	240			131		



RADIATOR INTEGRATED LOADS

Load banks for integration into the radiator cooling duct of generators. Utilising the airflow of the radiator is a cost-effective way of providing ballast load. This is useful for generators running at low load or as a test load during service inspections.

Rated for 400V 3ph. as standard, and consisting of two load steps, each 50% of the total load.

Power Rating (kW)	Load steps	Dimensions (mm)		
		Length	Width	Height
10 to 60	2 x 50% of total	670	830	230
70 to 100	2 x 50% of total	1250	1160	400
110 to 130	2 x 50% of total	1360	1160	400
140 to 160	2 x 50% of total	1360	1322	400
170 to 230	2 x 50% of total	1360	1484	400
240 to 300	2 x 50% of total	1260	1484	498



STATIC LOAD

NATURALLY COOLED LOAD BANKS

- **High reliability**
- **Virtually silent operation**
- **No moving parts**
- **No auxiliary supplies**
- **Minimal maintenance**
- **Any power rating**

Cressall can offer load banks that are cooled by natural convection.

These are virtually silent in operation and with no moving parts are extremely reliable, requiring minimal maintenance. Auxiliary supplies are generally not required.

A naturally ventilated load resistor rated 86MW at 13.8kV installed in Canada and used for testing gas turbines.



A Cressall 17.225MW three-phase load bank to loadtest the 11kV distribution system of the new Royal Navy aircraft carrier.

BANKS

FORCE COOLED LOAD BANKS

- **Compact design**
- **Cost effective**
- **Optional infra-red thermal protection**
- **Any power rating**

Cressall can offer force cooled load units. At higher powers these provide a cost effective and compact

alternative to naturally cooled units. Acoustic attenuation can be provided to meet specified noise levels. Units are supplied with thermal sensors and air pressure switches for protection.

All units can be supplied with switchgear and instrumentation if required.



6.6kV, 3.0MW ballast load for turbine load shedding.

Force cooling or natural ventilation
Suitable for any power and any voltage (ac or dc)
Single or multiple sections

RENEWABLE

The increasing importance of sustainable, low carbon power generation means that electrical engineers have to be able to confidently specify components and equipment that have been developed for use in such applications.

Cressall has made significant investment in the design and manufacture of resistors for the testing, generation and control of renewable energy:

Pre-Insertion Resistors

Crowbar Resistors

Neutral Earthing Resistors

Dynamic Braking Resistors

Load test

Resistors for Static VAR
Compensators



Harnessing the wind is one of the cleanest, most sustainable ways to generate electricity. Wind power produces no toxic emissions and none of the emissions that contribute to global warming. This, and the fact that wind power is one of the most abundant and increasingly cost effective energy resources makes it a viable alternative to burning fossil fuels.

Cressall Resistors designs and manufactures a range of components that form essential parts of any wind-farm installation.

ENERGY



Using the sun's rays to generate electricity or to heat water is a well proven technology and even here resistors can help to improve the efficiency of the collector systems.

Solar panels which can track the sun to ensure optimum efficiency will often use electric drives in their positioning system, like the electric drives in hybrid vehicles these can use Cressall braking resistors to ensure that the panels stop when required, and as these resistors are passive devices and have no wearing components they will last as long as the panels themselves.



Although tidal power generation is not as common as wind or solar generation its predictability gives significant advantages. The relatively high set up costs combined with the restricted locations into which the equipment can be installed is gradually being offset by improving turbine technology.

Cressall's extensive marine experience gained supplying both air and water cooled brake resistors as well as submerged load resistors means we are ideally placed to meet not only the electrical and thermal requirements of tidal power applications we can also make a product which will operate effectively in the harsh marine environment.

A tidal stream generator operates in much the same way a wind turbine does and so has similar requirements for the resistors manufactured by Cressall.

EV2 WATER COOLED M

EV2 is Cressall's new range of water cooled resistors for low and medium voltage applications, especially for severe conditions in automotive, traction or marine systems.



Manufactured from advanced materials the EV2 is a patented design that encapsulates and totally separates the resistor elements from the coolant providing a modular light weight, low volume, high power solution for water cooled applications, units can be combined together to handle powers from 10kW to 1.0MW

Units can be supplied as individual components or back plate mounted assemblies for inclusion in customers systems or completely enclosed multi-banked systems including inlet/outlet manifolds, flow and temperature monitoring.



Applications of the EV2 include:

Braking of:

- Hybrid and all-electric vehicles
- Winches and cranes
- Cable laying vessels
- Propulsion drives on ships or oil rigs

Other applications:

- Dummy loads and discharge resistors for mV electrical systems
- Liquid heating



MODULAR RESISTOR

Operating voltage

Continuous operating voltage up to 1.5kV

Advanced materials

Light weight, low volume, high (10kW/kg) power density

Modular construction

EV resistors can be combined to handle any power inputs from 10kW to 1MW or more.

Extensively tested

Proven to meet all major shock and vibration standards for automotive/traction use.

Up to IP67 ingress protection

Suitable for automotive/traction/marine use.

Low time constant

Full output temperature within 2 sec for heating applications.

Power

Continuous powers of up to 25kW per EV module

Overloads:

10% for 60s, 20% for 15s, 30% for 5s

(subject to maximum current rating per EV2 of 250A)

Resistance (hot)

Minimum 0.1 Ω , maximum 15 Ω per EV2 module

Weight (empty)

EV2: 2.7kg

4EV2: 10.7kg

Operating pressure:

1.5 - 3 bar max

Test pressure: 6 bar

Burst pressure: 10 bar

Cooling medium

Fresh water or water glycol (max glycol 50 %).

Operating conditions Ambient temperature

-30° to +50°C (operation),

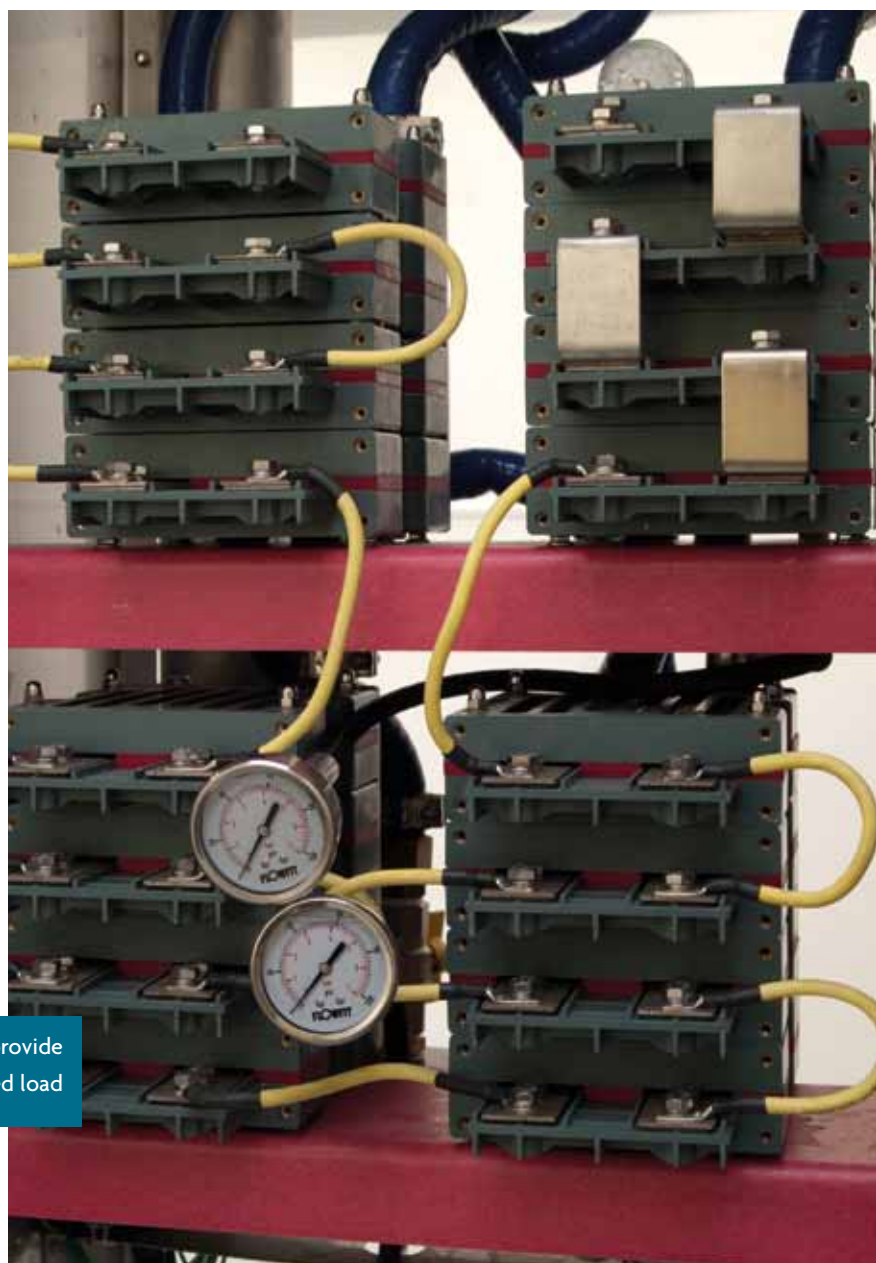
-40° to +80°C (storage)

Cooling flow rates

Minimum flow for 20°C temp. rise:

18 l/pm

Pressure drop at 18 l/pm: 0.8 bar



Multiple EV2 units assembled to provide a single 400kW water cooled load

EXPANDED MESH

Versatility

Cressall engineers can select expanded mesh with any configuration of element length, cross-section, material thickness, banking arrangement and cooling method to suit the requirements of the application.

Expanded mesh resistors can be made from any suitable resistance material. As standard Nickel-chrome and iron-chrome-aluminium alloys are used. The selection is based upon cost, temperature coefficient of resistance and magnetic properties.

Excellent heat dissipation

Expanded mesh elements provide a very large surface area relative to mass, giving excellent heat transfer capabilities and making them ideal for continuous duties.

The active material, insulators and mountings on expanded mesh resistor elements are designed to maximise the use of convecting air for ventilation. An unrestricted path through the active material avoids 'hot spots' and local overheating.

Expanded mesh resistor elements cool from 600°C to almost ambient temperature in approximately one-eighth of the time taken by an average grid. This means that expanded mesh resistors are also suitable for continual 'on/off' cycles, making full use of the 'off' periods for rapid cooling.

Light weight

Expanded mesh elements and their mountings are lighter in weight per kilowatt than any other known type.

Negligible inductance

In tests up to 1MHz, expanded mesh resistor elements have been demonstrated as non-inductive for all normal practical purposes.

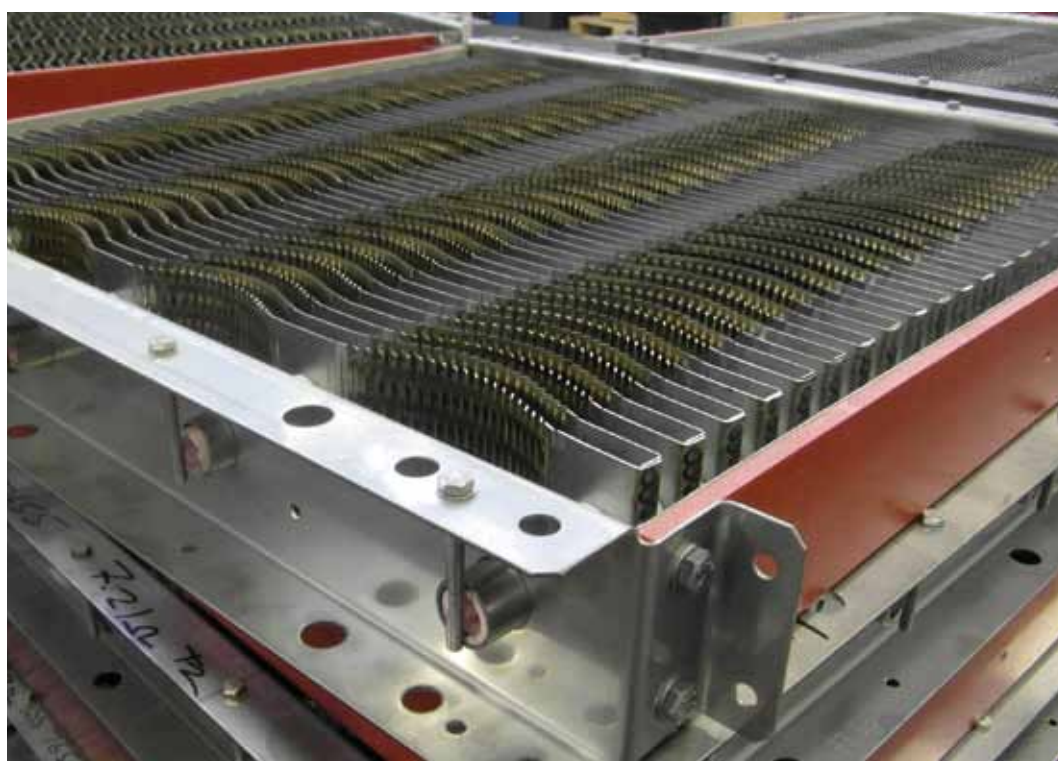
Durable construction

Expanded mesh elements are robust and capable of withstanding vibration, yet sufficiently flexible for shock absorption.

Elements have the advantage of fixed mountings: movement due to thermal expansion is absorbed within the mesh structure itself.

Although the heated part of the element and the metal supporting it are formed from a single sheet, heat is kept out of the mountings, terminations and supporting insulators to a much greater extent than with other designs.

Primary insulation consists of mica based tubes and alumina spacers. Secondary insulation consisting of ceramic insulators may be added to permit operation at any required voltage level.



EDGEWOUND COILS

Cressall offer a range of standard resistor elements which can be supplied loose, in banked assemblies or in full enclosures.

- **Versatile and robust**
- **Good heat dissipation**
- **High overload capacity**
- **Standard coil sizes**
- **Standard banking designs**

Edgewound Coiled Strip Resistors

Cressall's edge-wound coiled strip resistors are an efficient way to package a large resistance mass into a small space. The high mass and robust design provides exceptional short-term overload capacity.

Applications include:

- **Neutral earthing**
- **Dynamic braking**
- **Motor starting and speed control**
- **Load testing**

Construction

All styles are manufactured from a continuous stainless steel strip wound edgewise to form a coil which is then fitted on ridged ceramic insulators and supported on a central steel support strap.

Elements can be supplied either loose, as banked assemblies or mounted in a range of standard ventilated enclosures, according to customers requirements.





RP COILS

Manufactured from an oval wound stainless steel strip the RP resistor is an efficient method of packaging a large resistor mass in a small volume. One coil can hold up to 12kg of active resistor material. RP coils are most commonly used in neutral earthing and high energy motor control applications.

Supplied either as loose coils or in banks up to twelve coils wide and up to eight tiers high, they offer a high degree of versatility to fit within any specified envelope.

The resistor stacks are mounted on base insulators and are self-supporting and free standing. This means that they can be easily incorporated in to customers own enclosures when required.

Each coil is locked on to its supporting bank by clamps and all the electrical connections between elements are made by double bolted copper connections. This allows removal of an individual element from the assembly without disturbing the complete arrangement.

ZC COILS



ZC coils offer the versatility of 108 different designs for medium current applications.

Units can either be supplied with fixed resistance taps or loose adjustable tapping clamps to allow customer selection of the appropriate ohmic value.

Supported on M8 threaded rod, they are insulated for operation at up to 800V and can be supplied loose, mounted between end plates or housed in one of our standard range of enclosures.

WIREWOUND COILED COIL RESISTORS

For applications requiring lower powers or higher resistance values Cressall offers the coiled coil resistor elements.

Applications include:

- Neutral earthing
- Dynamic braking
- Harmonic filters
- Load testing

HP COILED COILS

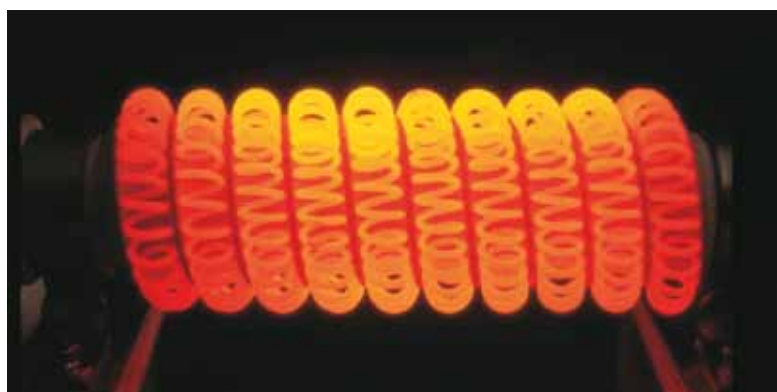
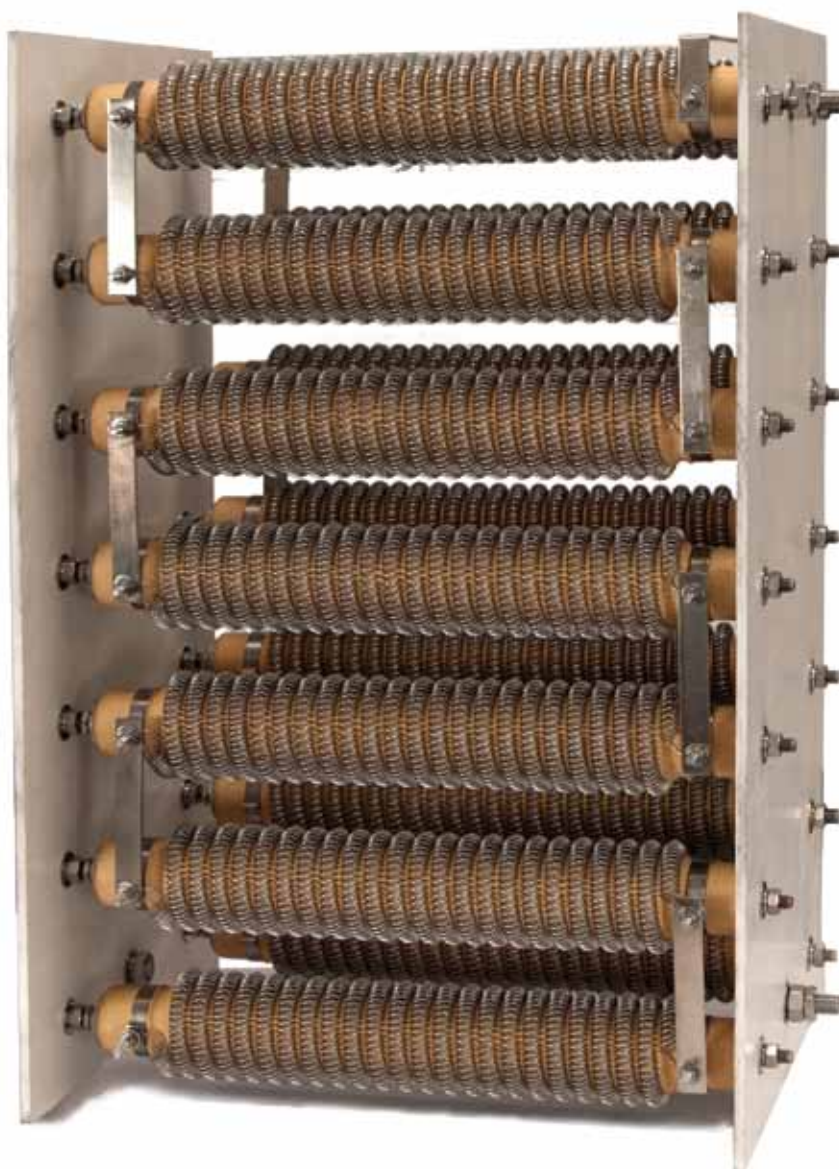
The HP coiled coil resistor was originally developed for use in dynamic braking. Its open wound coil arrangement allows operation at up to ten times its normal power rating for short periods while retaining quick cooling times.

In addition to braking applications it is now used frequently in neutral earthing resistors, harmonic filter resistors and for load testing.

Three different sizes of resistor elements are offered, 600W, 1000W and 1500W continuously with individual coil resistance values up to 300ohms.

Elements can be supplied individually on mounting brackets, on open banks or as full assemblies where multiple coils are connected together to achieve the required rating.

Two high grade stainless steel alloys are used depending on the application either iron/chrome/aluminium or nickel/chrome.



Cressall offer a range of grid resistors suitable for most applications, which offer different packaging dimensions and are often used for spare replacement and retrofit of resistor systems supplied by other vendors.

SERVICE GRIDS



- **Modular**
- **Shock and vibration resistant**
- **Range of standard enclosures**
- **Specifically designed for motor control**

Service grids are a robust flat plate style of resistor manufactured from 304 grade stainless steel elements insulated using mica and welded together

to form a continuous low inductance resistance path. Service grid resistors can be supplied as either open banks or housed in ventilated enclosures.

Every grid has punched holes within the welded contact section to give intermediate tapping points.

Enclosures

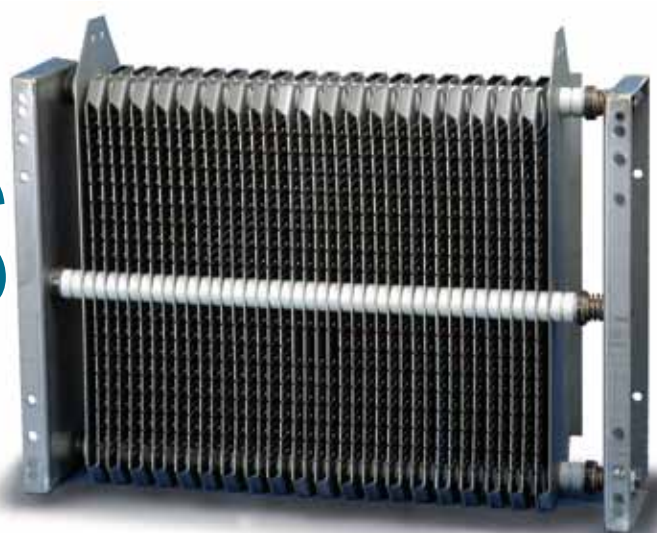
There are two standard enclosure styles for service grid resistors; Industrial Housings for general purpose applications and System 22 Housings designed for steel mills, this allows the replacement of individual banks without disturbing other banks in the enclosure.

Either type of enclosure can be supplied as painted mild steel, hot dip galvanized to BS729 or natural finish grade 304 stainless steel.

HPR AND HG GRIDS

- **Versatile, robust construction**
- **For continuous and short-term ratings**
- **High ratio of surface area to active mass**
- **Wide range of resistor materials**

HPR and HG grids are versatile plate style resistors available in a range of different resistance alloys, they are ideal for medium and high power electric braking, neutral earthing and load testing. The flat plate construction means fan assisted cooling can be offered for higher power applications.



The electrical connections between elements are double bolted. This allows removal of an individual element from the assembly without disturbing the complete arrangement.

STRIP ELEMENTS

Strip Type elements including Hi-temp, Eurostyle and new EHT all have the following features:

- **Modular Construction**
- **Ease of assembly/disassembly**
- **Unique element profile**
- **Two levels of primary insulation**
- **Corrosion resistant construction**
- **Lightweight, relative to loading density**
- **Shock/vibration proof**
- **Natural convection or fan cooling**

Cressall's Strip Type Resistors were developed for use in extreme operational conditions including severe shock and vibration, adverse weather, corrosive environments, extremes of temperature, and high overload margin, originally developed for use in rail traction market they are now also used in off shore marine braking and load testing.

Resistor banks are made up of a single row of "serpentine" shaped elements the ends of adjacent elements for Hi Temp and EHT are spot-welded together to form a continuous path or for Eurostyle a continuous element with no welds between the terminals.. Two rows of ceramic insulators are employed as the main supports for these elements. This method of support provides discrete accommodation for thermal expansion while providing excellent security against damage through vibration or shock.

Insulation

Both grid and strip type elements are insulated from the mounting rods by non-hygroscopic ceramic insulators, chosen to provide superior levels of both thermal and mechanical shock. These insulators are in a constant state of controlled compression either through tension springs or torque levels applied to fasteners, with no shearing effects, and will withstand levels of vibration and shock without damage. Each mating face has a spheroidal shape that acts as a bearing, permitting movement in service while avoiding the creation of crevices which could result in contaminant ingress. A thin tube of high temperature, silicon-bonded integrated mica is employed between the ceramic insulators and the mounting rods to enhance the electrical insulation under the most adverse conditions.



RESISTOR MATERIALS FOR USE WITH ALL GRID RESISTOR ELEMENTS

Alloy	Composition %	Temperature Range °C	Temp co-efficient of resistance
FeAlCr	Bal/15/14.5	20 - 1000	+0.00011 /°C
NiCr(1.4845)	20/25	20 - 1000	+0.00005 /°C
NiCr	30/20	20 - 1000	+0.00025 /°C
NiCr	37/18	20 - 1000	+0.00022 /°C
NiCr	60/16	20 - 1000	+0.00008 /°C
NiCr	60/23	20 - 1000	+0.00009 /°C

RESEARCH & DEVELOP

ENGINEERING DESIGN TOOLS

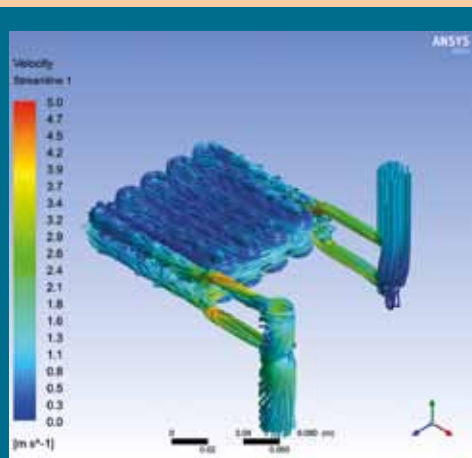


ANSYS Finite Element Analysis simulation being carried out in our Leicester design office.

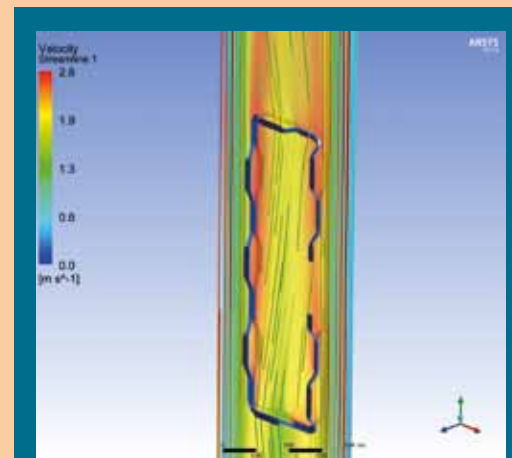
All Cressall's products are designed, engineered and manufactured at our sites in Leicester and Dereham using the very latest computer-aided design tools – we have full-time qualified engineers, using Autodesk Inventor for 3D modelling and design, ANSYS for thermal, structural, seismic and fluid flow analysis and Radan as the interface with our metalworking machines.

These resources plus a library of more than forty years of proven designs and test data enable us to respond quickly and accurately to new product requests.

Designs initially conceived by our experienced engineers are first proved by using CAE models and then full-scale tested in order to meet our customers' requirements.



Simulation of water velocity distribution within an EV resistor design. The images generated by this analysis enabled the link between empirical results and fluid dynamics theory to be linked together. The resulting images give a very good visual representation of the system in action.



Modelling of air velocity generated by natural convection heat transfer from a resistor element running at full power. This analysis enables the distribution of the resistor elements to be optimised for a high power load bank design.

TESTING AND TEST EQUIPMENT

We have calibrated test equipment for all routine testing, including resistance and inductance meters, temperature gauges and a 100kV dielectric tester.

For high power or high voltage testing, including impulse tests up to 400kV and full load testing of

load banks and brake resistors, we have access to the best-equipped test laboratory of any resistor manufacturer in the world.

This is used both for in-house development and for routine and type-testing customers' equipment.



REPLACEMENT RESISTORS

Over the years Cressall have acquired other resistor companies and have successfully integrated their technology into our range. In many cases this means we have a library of technical and contract data to which we can refer.

We can also supply resistors that can be used to replace our competitors' products, this we can do providing we know the rating or the duty of the resistor involved.

We hold information on resistors previously supplied under the following names:

- **GEC Alsthom**
- **GEC Industrial Controls**
- **Eaton Cutler Hammer**
- **British Thompson Houston (BTH)**
- **AEI**
- **Fawcett Preston**
- **H. A. Birch**
- **Expamet**
- **E. A. Walshe**
- **BHI**
- **TPR Resistors**

CRESSALL

INDUSTRIAL POWER RESISTORS

More information, including comprehensive data sheets, about Cressall's advanced resistor range and design services is available from your local distributor, Cressall's U.K. office or our fully informative website.

www.cressall.com



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