Exploding Capacitors

A letter was received describing an incident in which a capacitor exploded. The circumstances were as follows :

An electronics circuit board was being powered by an un-regulated low-voltage power supply set to the nominal voltage required. The board was fitted with a tantalum electrolytic capacitor which "exploded throwing out white-hot fragments which burned small holes in the surrounding furniture".

This is not a topic which comes to the attention of the Sub-committee as often as some others, but it is by no means new. It is clearly something of which teachers need o be reminded from time to time.

The explosion was undoubtedly due to the rapid generation of gases within the capacitor together with overheating, both resulting from the passage of an alternating current greater than that which the capacitor was designed to handle. This current was high because:

- an un-regulated supply produces a higher than nominal voltage when supplying a low current (as taken by an electronic circuit); and
- a general purpose school power unit provides a unidirectional but unsmoothed voltage when set to dc.

This voltage is equivalent to a true dc level with non-sinusoidal ac at 100 Hz superimposed on it. It is this ac component which gives rise to the "ripple current" and a smoothing capacitor must be designed to carry it. The maximum value quoted in the RS Catalogue is 18.5 A for an aluminium electrolytic, but no values are quoted for tantalum types which are stated as being suitable for "coupling, bypassing, filters, timing circuits and general applications". However, a warning is given that the surge voltage rating should not be exceeded.
Ideally, such circuit boards should be powered by a regulated power supply (which would also provide a smooth output) or by batteries. If a general purpose supply must be used, a suitable smoothing capacitor could be connected across the output but the voltage setting must then be reduced until the measured voltage is that required. This is, of course, because the voltage across the capacitor will rise towards the peak value of the unsmoothed output.

One could also argue that the designer of the circuit board should make clear that a smooth supply is required or the capacitor should be suitable for any supply. This latter alternative would probably require a physically larger board and the unit would be more expensive: a consequence which no one wants.
It is to be hoped that the staff in the school concerned were able to use this dramatic demonstration to good teaching effect.

Note: If a capacitor is used to smooth an unsmoothed dc supply, it must also have a suitable ripple current rating. As a rule of thumb, the ripple current is twice the load current, so choose a ripple current rating twice the

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maximum current output of the power supply. The capacitor must also have a suitable voltage rating, say 50% higher than the maximum power supply voltage for a good safety margin. Make sure to observe the capacitor polarity.