
Safeguarding against ELECTRICALLY- CAUSED FIRE

Richard Nute
Product Safety Consultant
San Diego

agenda

- **DEFINITION**
 - ELECTRICALLY-CAUSED FIRE
- **SAFEGUARDS AGAINST ELECTRICAL IGNITION**
 - AUTOMATIC DISCONNECTION OF THE SUPPLY
 - LOW RATE OF THERMAL ENERGY TRANSFER TO A FUEL MATERIAL
 - APPLICATION OF FLAME RETARDANT MATERIALS
- **SAFEGUARDS AGAINST SPREAD OF FIRE**
 - PREVENT SPREAD OF FIRE FROM THE POINT OF IGNITION
 - PREVENT SPEARD OF FIRE THROUGH THE ENCLOSURE

Electrically-caused fire

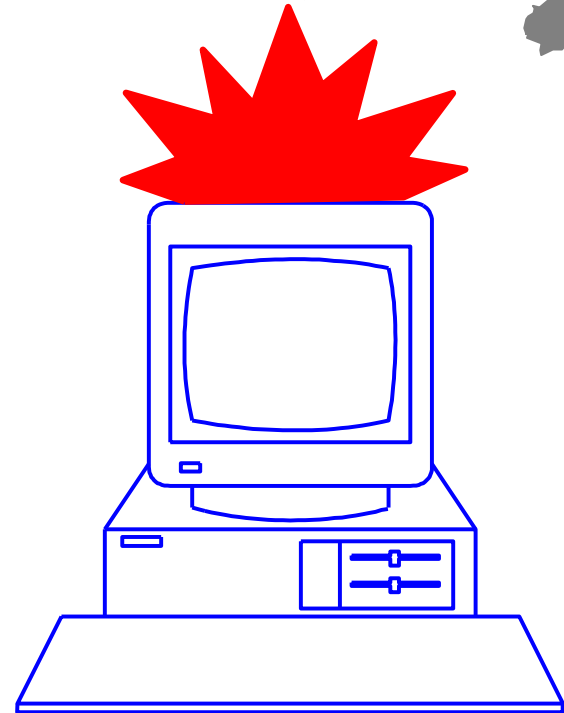


Electrically-caused fire is

- **electrical heating of a material to ignition temperature**

followed by

- **ignition and**
- **combustion.**



Ignition and spread of fire

As with most manually-started fires, electrically-caused fires start with physically small (power-dissipating) heat sources that heat small units of adjacent fuel to ignition.

The small units of fuel ignite larger units of fuel, spreading the fire.

Electrical heating

Electrical heating occurs when *ELECTRICAL ENERGY* is converted to *THERMAL ENERGY*.

Electrical energy is converted to thermal energy in a *RESISTANCE*.



Electrical heating is expressed in *WATTS*.

$$1 \text{ watt} = 1 \text{ joule/second}$$

$$P = I^2 * R$$

$$P = E^2 / R$$

$$P = E * I$$

Normal operating conditions

ELECTRICALLY-CAUSED FIRES DO NOT OCCUR UNDER NORMAL OPERATING CONDITIONS.

Under normal operating conditions, the **principal safeguard** against fire is:

- *prevention of fuel material temperatures from exceeding rated material temperatures.*

*A **principal safeguard** is a safeguard that is effective under normal operating conditions whenever hazardous energy is present.*

Fault conditions

ELECTRICALLY-CAUSED FIRES ONLY OCCUR UNDER FAULT CONDITIONS.

Under fault conditions, the **supplementary safeguards** against fire are:

- *prevention of ignition, and*
- *prevention of spread of fire, either within the equipment or from the equipment*

*A **supplementary safeguard** is a safeguard that is effective in the event of failure of the principal safeguard.*

FIRE SAFEGUARDS

SAFEGUARDS AGAINST ELECTRICAL IGNITION

devices for automatic disconnection of the supply

low rate of thermal energy transfer to a fuel material

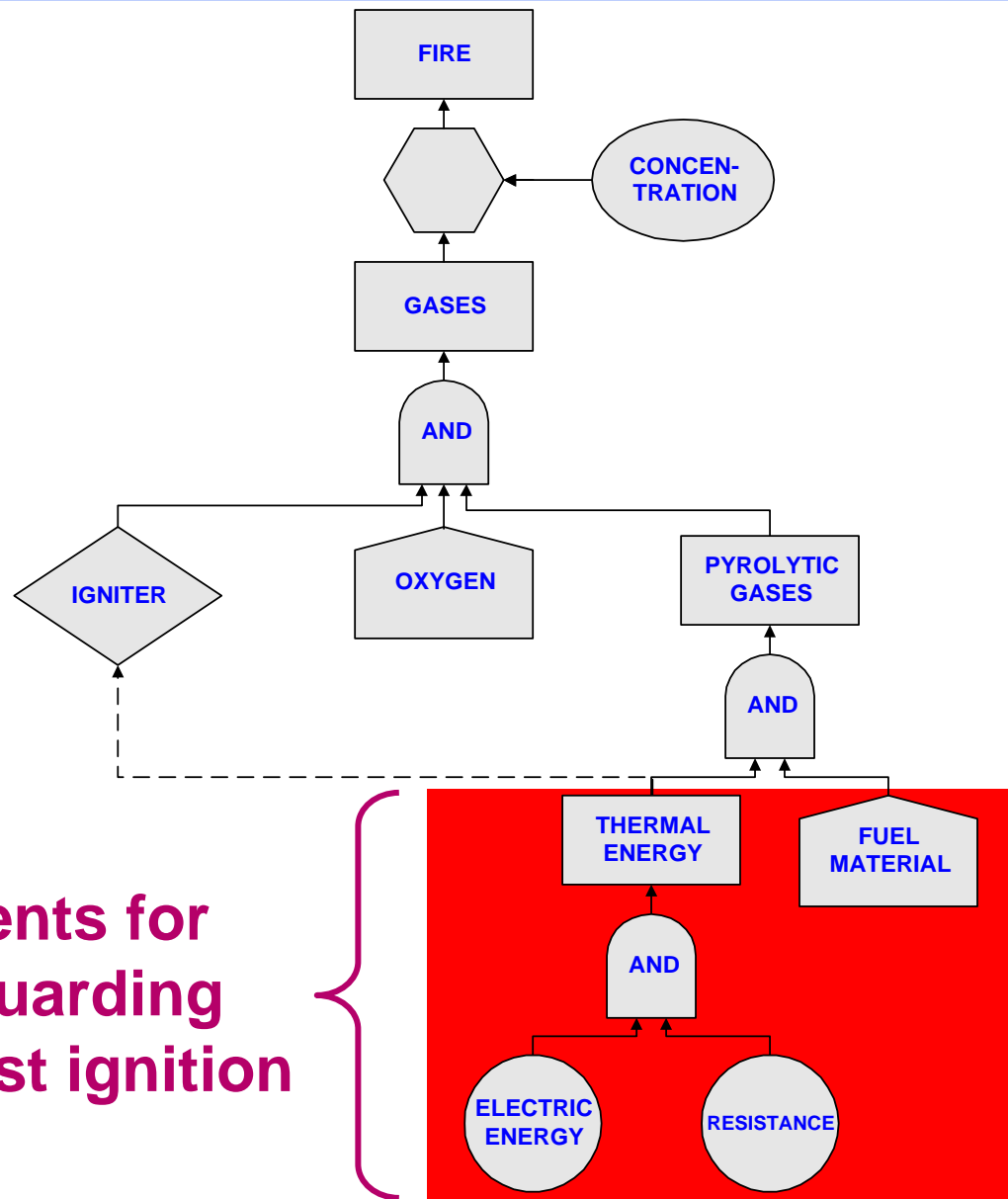
application of flame-retardant materials

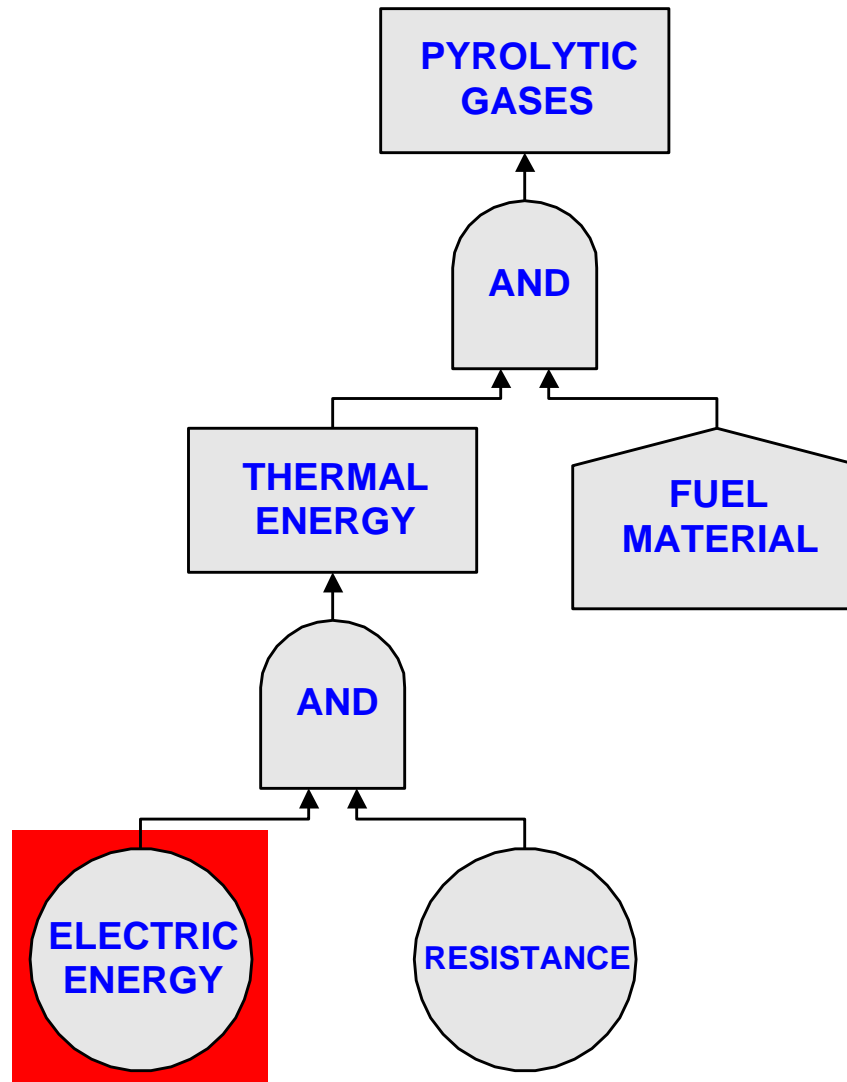
SAFEGUARDS AGAINST SPREAD-OF-FIRE

prevent spread of fire from the point of ignition

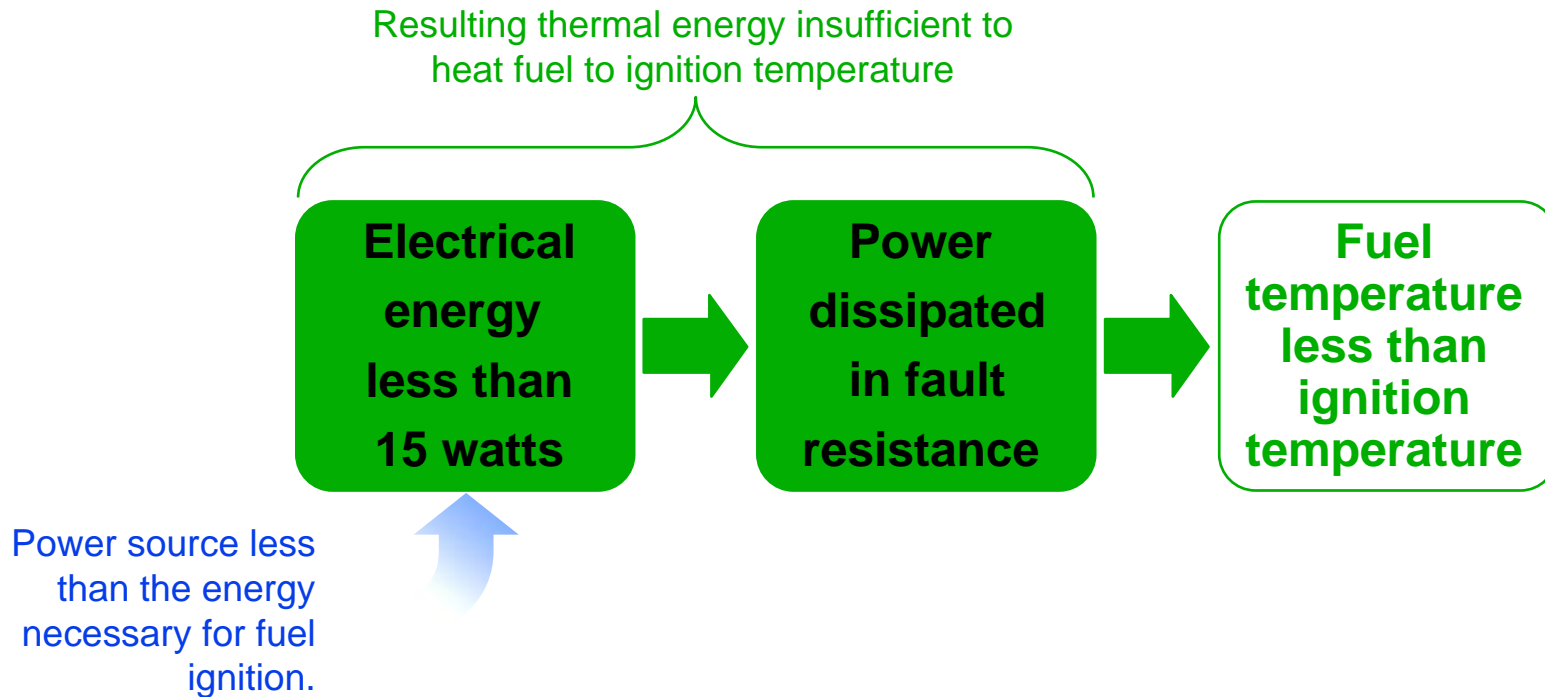
prevent spread of fire through the enclosure

Elements for
safeguarding
against ignition

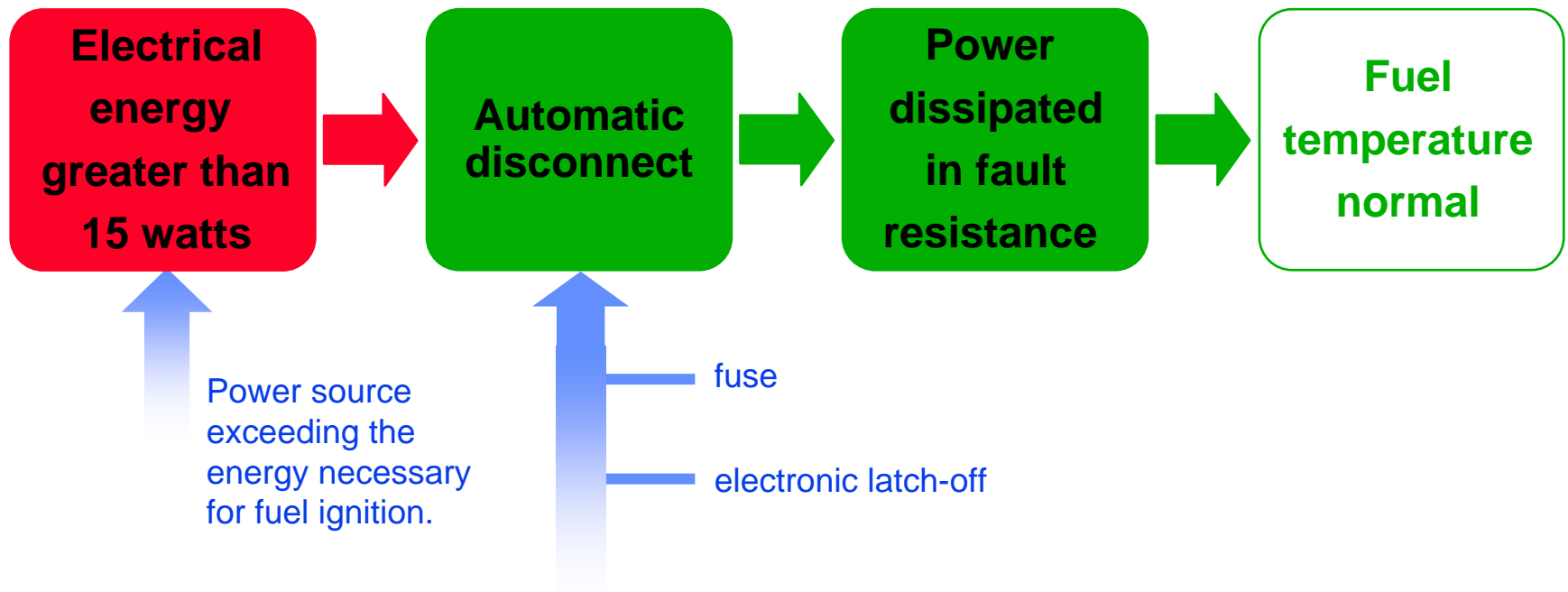


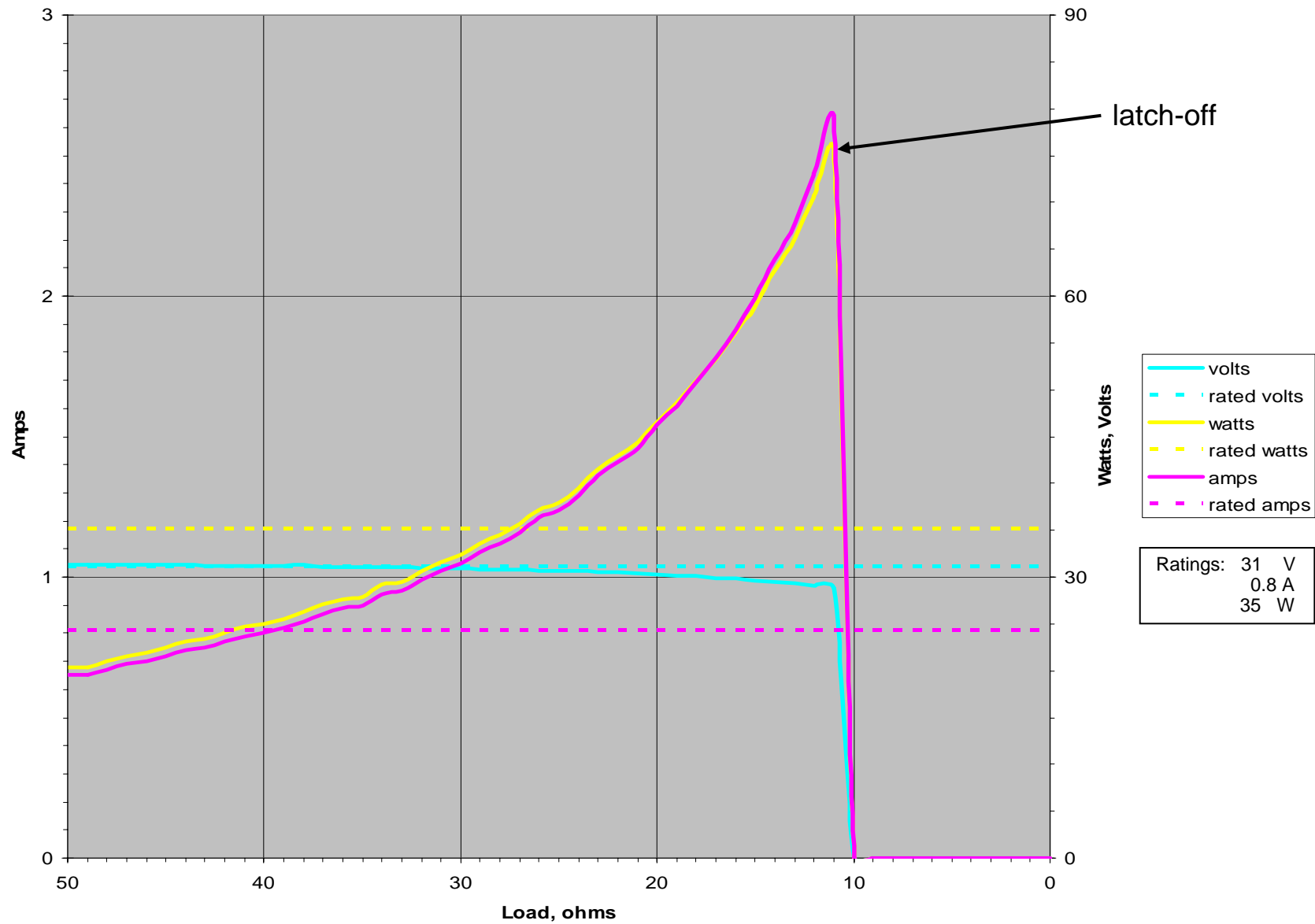


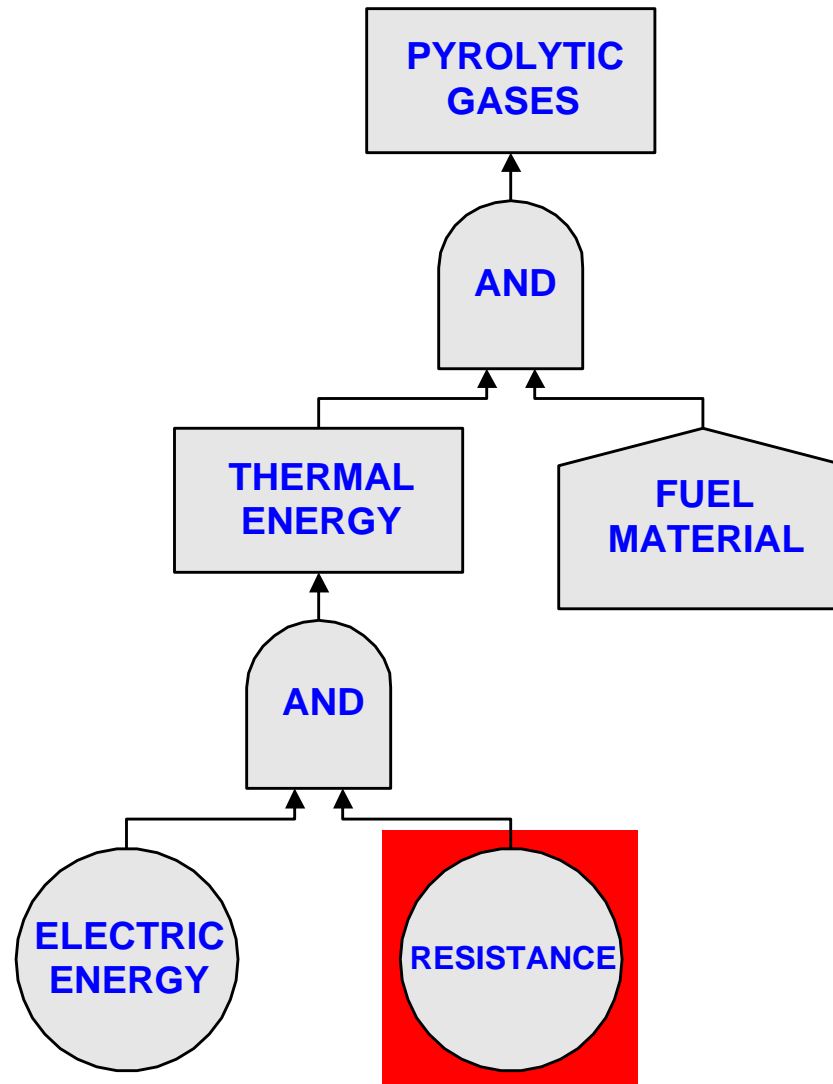
IGNITION SAFEGUARDS



IGNITION SAFEGUARDS

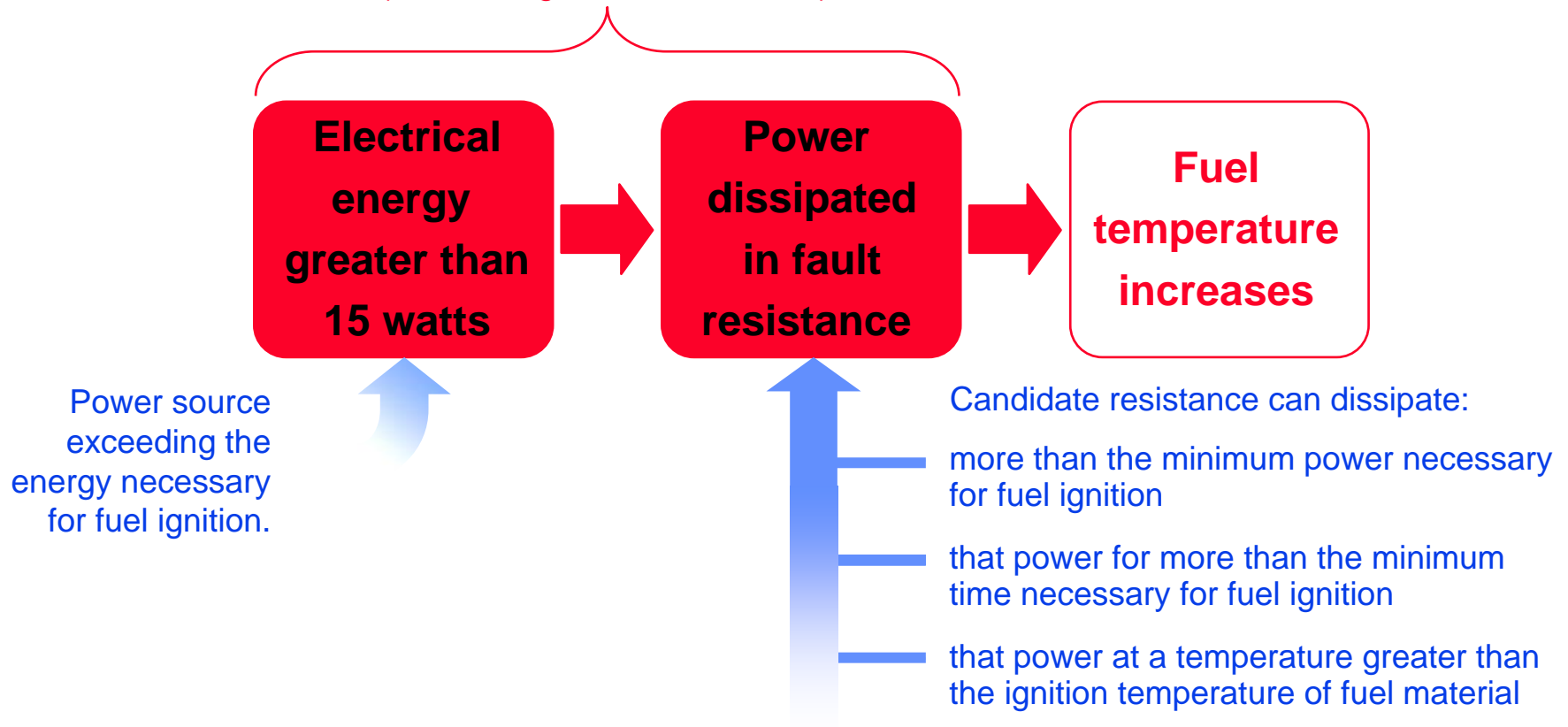






IGNITION SAFEGUARDS

Electrical energy to thermal energy
(Potential Ignition Source, PIS)



Examples of candidate resistances

Power distribution devices

transformers
rectifiers
series-pass transistors
connectors/connections
conductors

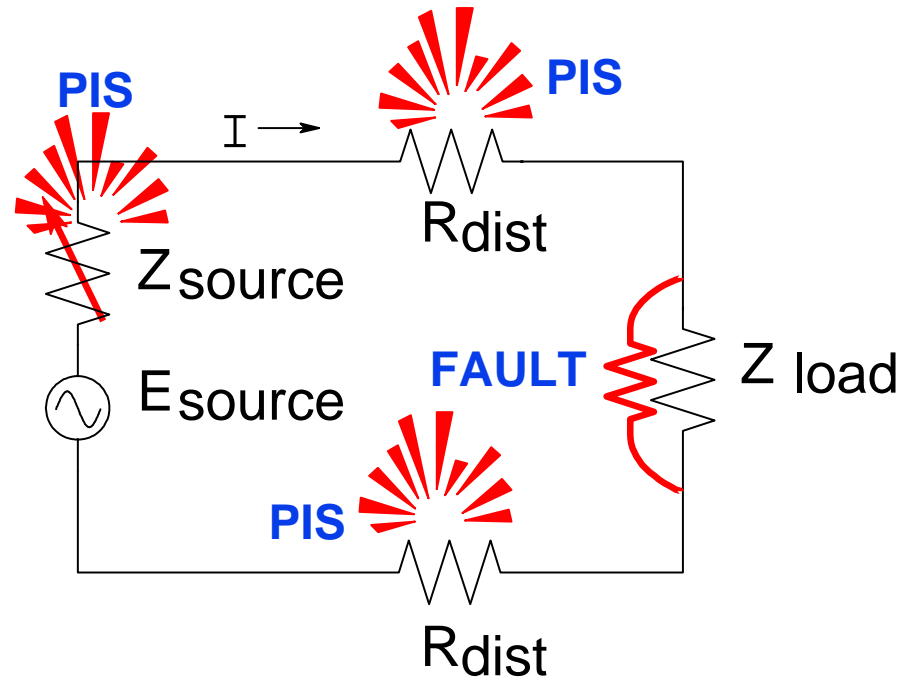
Power consuming devices

resistors
semiconductors (linear)
motors
solenoids

Examples of candidate resistances

Effects of load faults

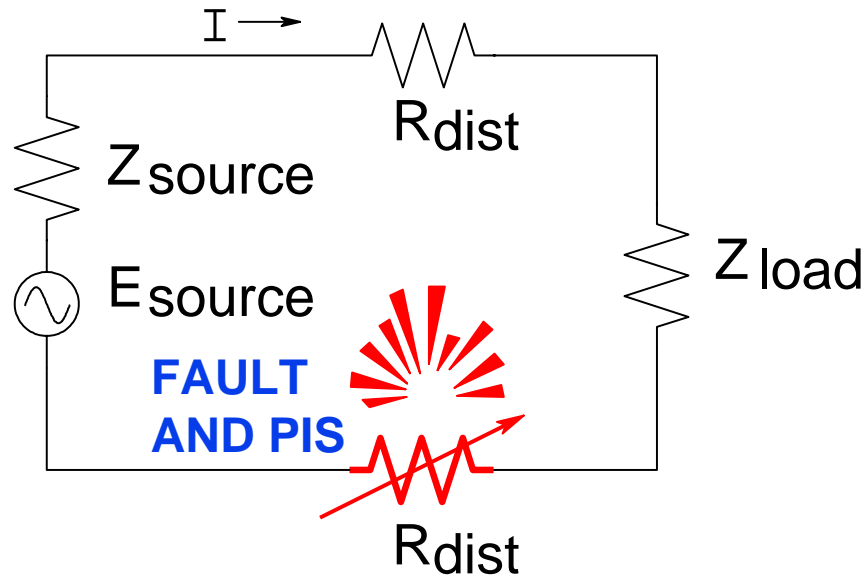
$$P = I^2 * R$$



Examples of candidate resistances

Effects of distribution faults

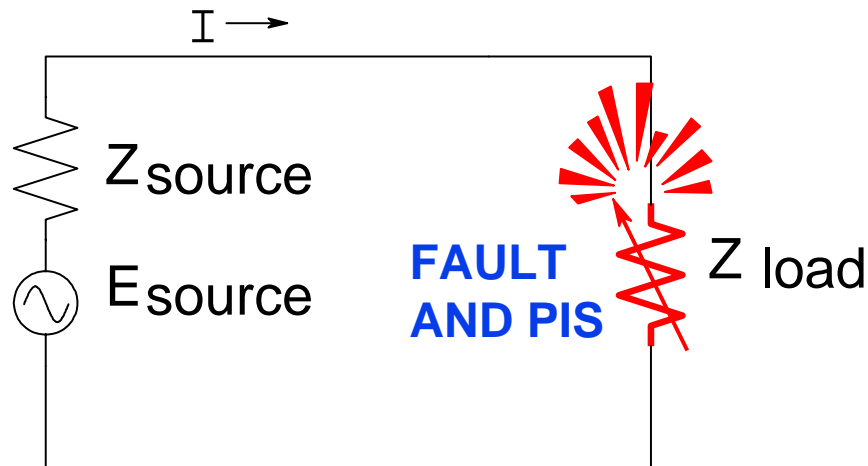
$$P = I^2 * R$$



Examples of candidate resistances

Effect of component faults.

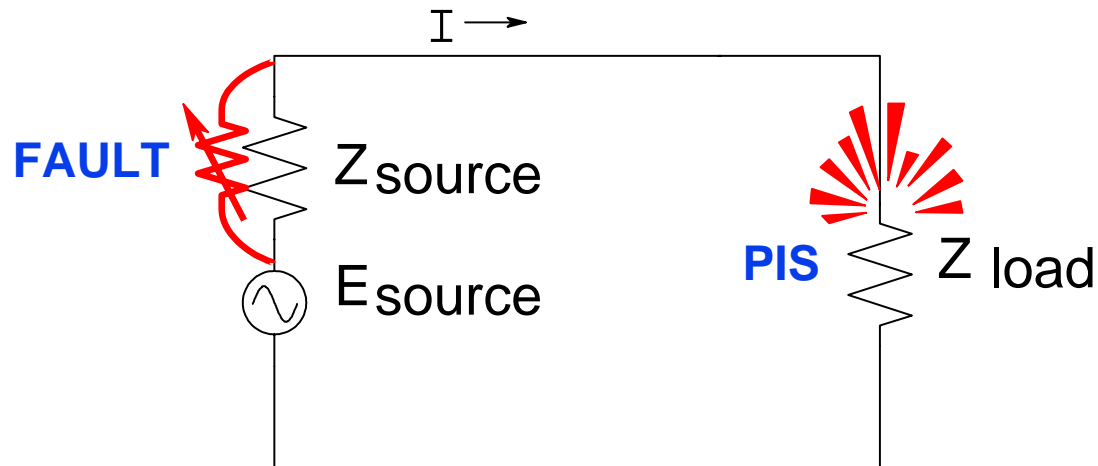
$$P = E * I$$

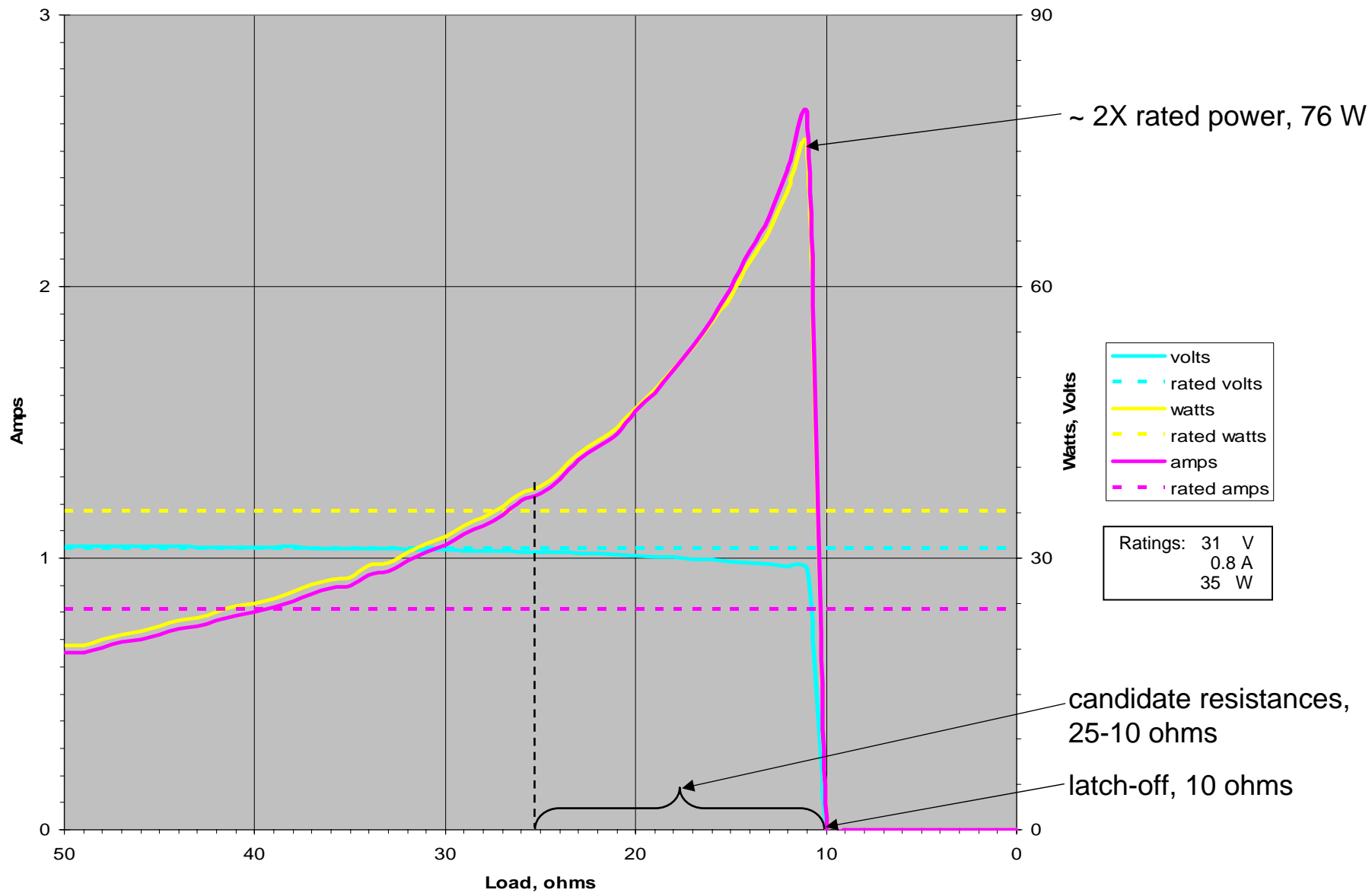


Examples of candidate resistances

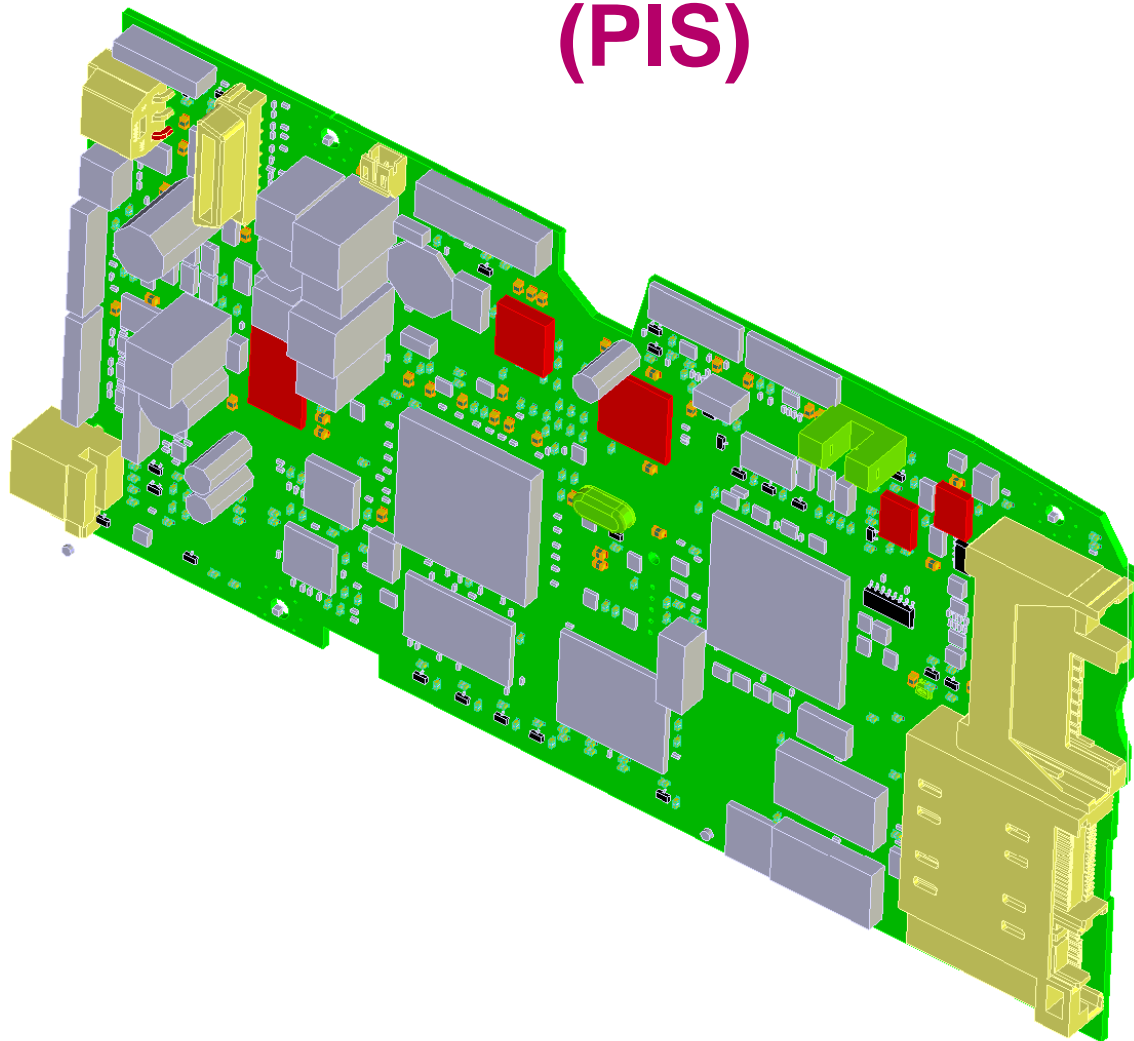
Effects of source faults.

$$P = E^2 / R$$



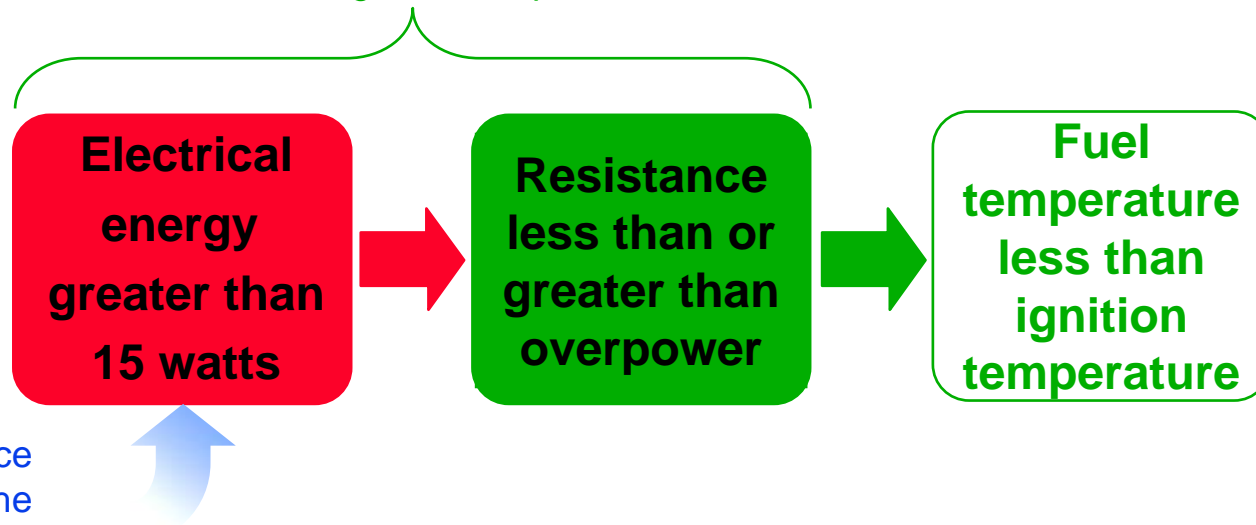


Candidate power-dissipating devices (PIS)

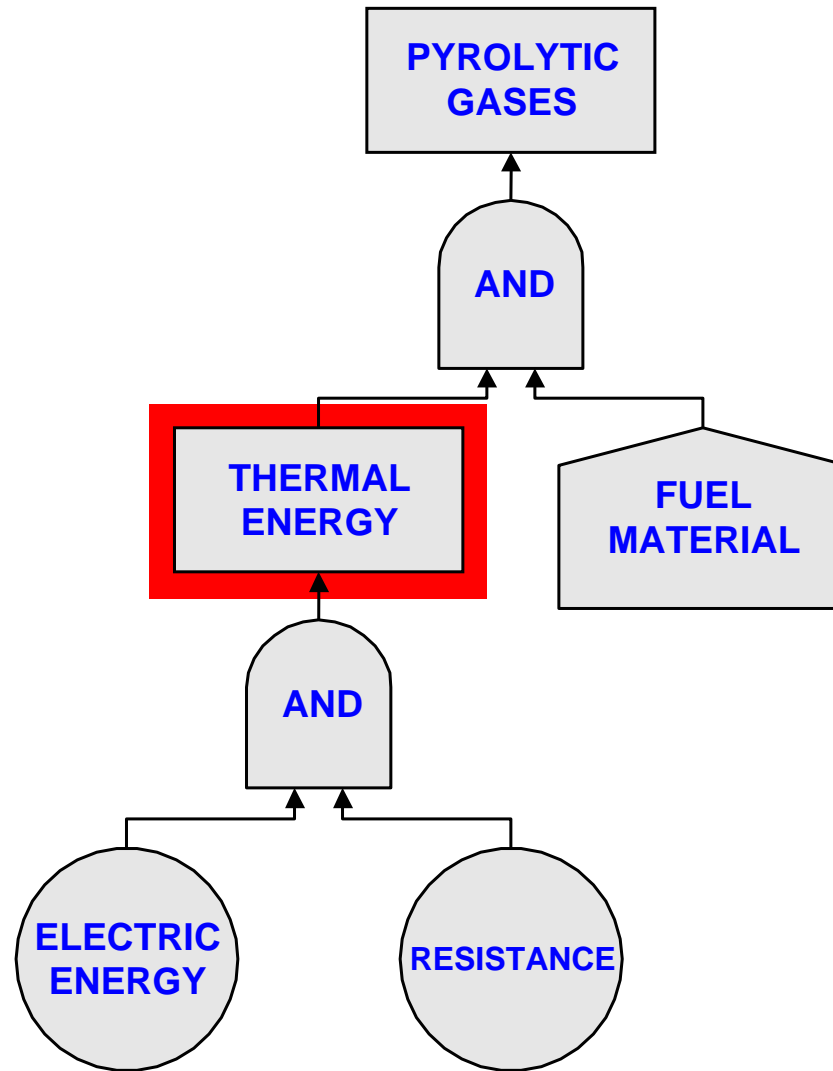


IGNITION SAFEGUARDS

Resulting thermal energy insufficient to heat fuel to ignition temperature

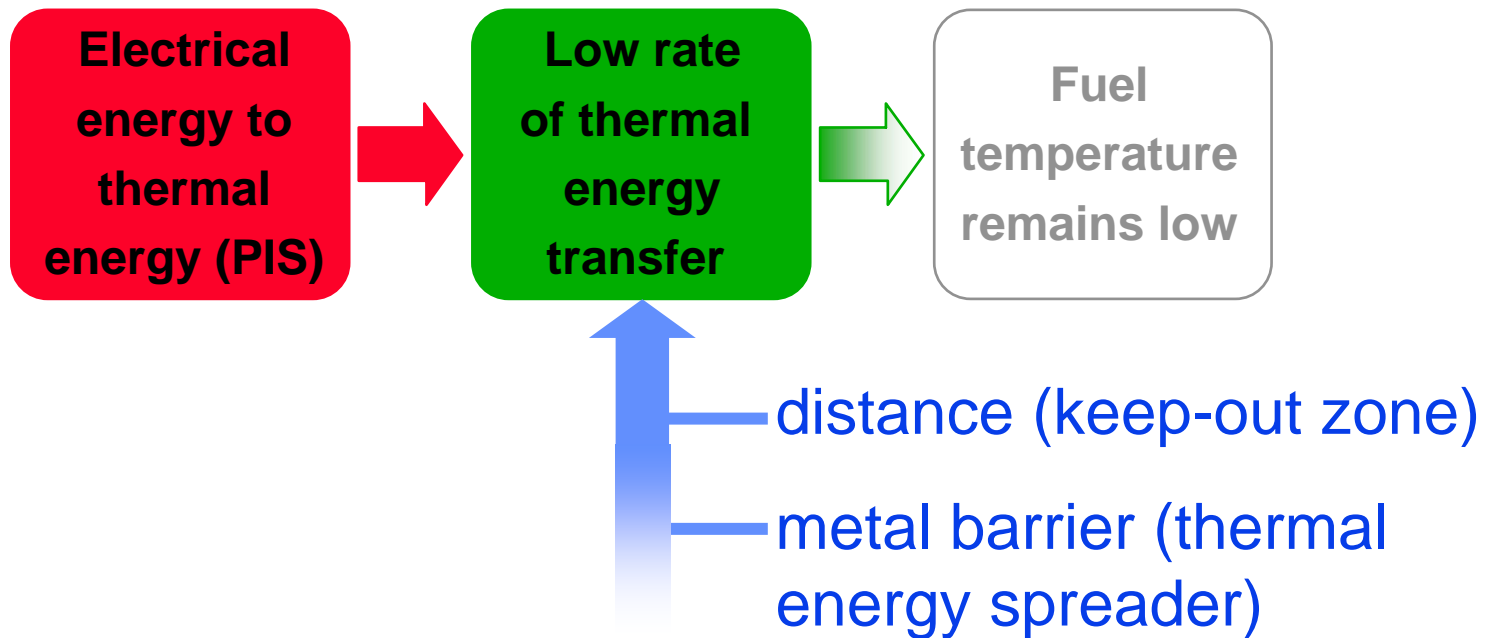


Power source exceeding the energy necessary for fuel ignition.



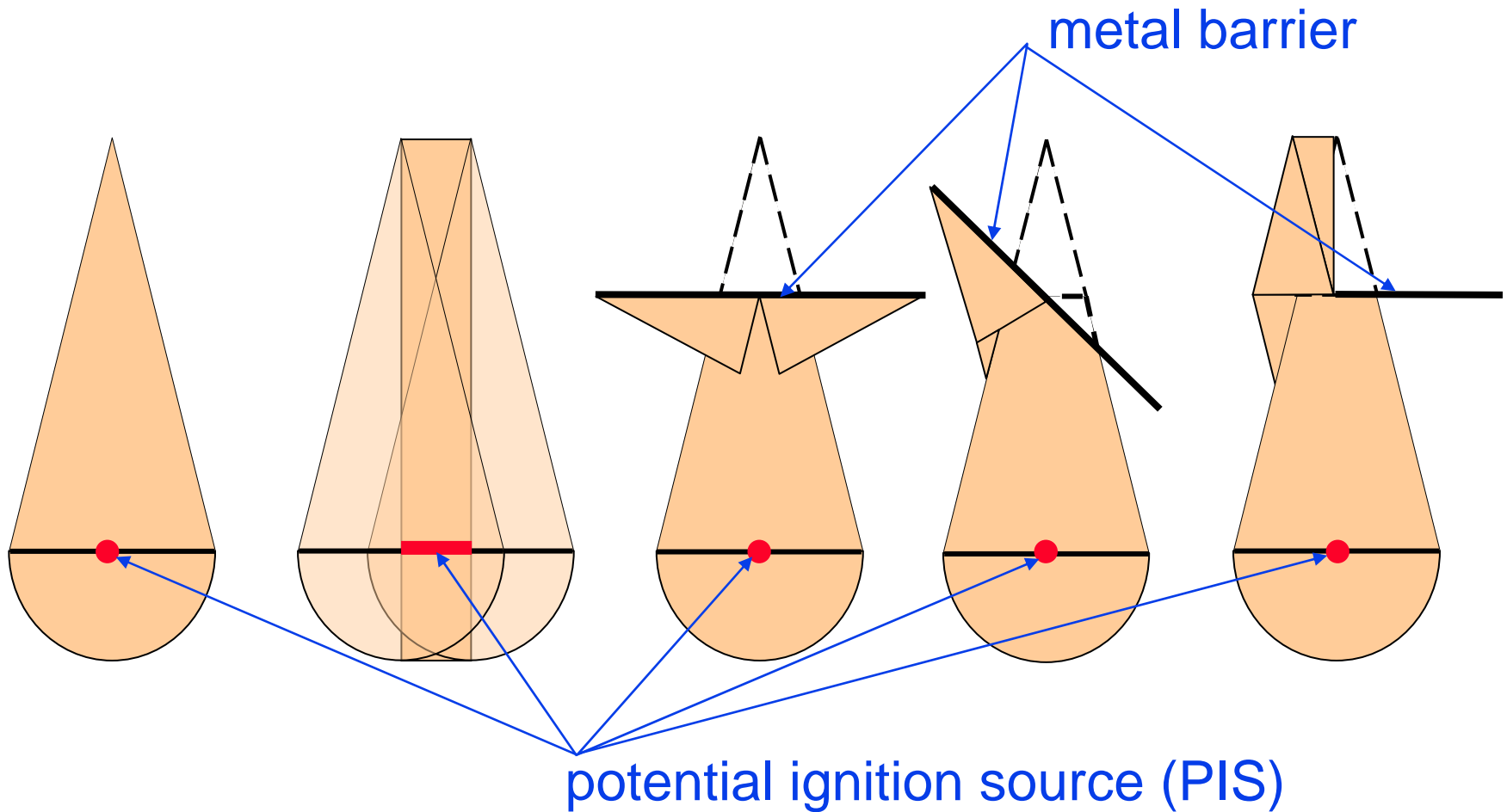
IGNITION SAFEGUARDS

Thermal isolation between thermal source and fuel:

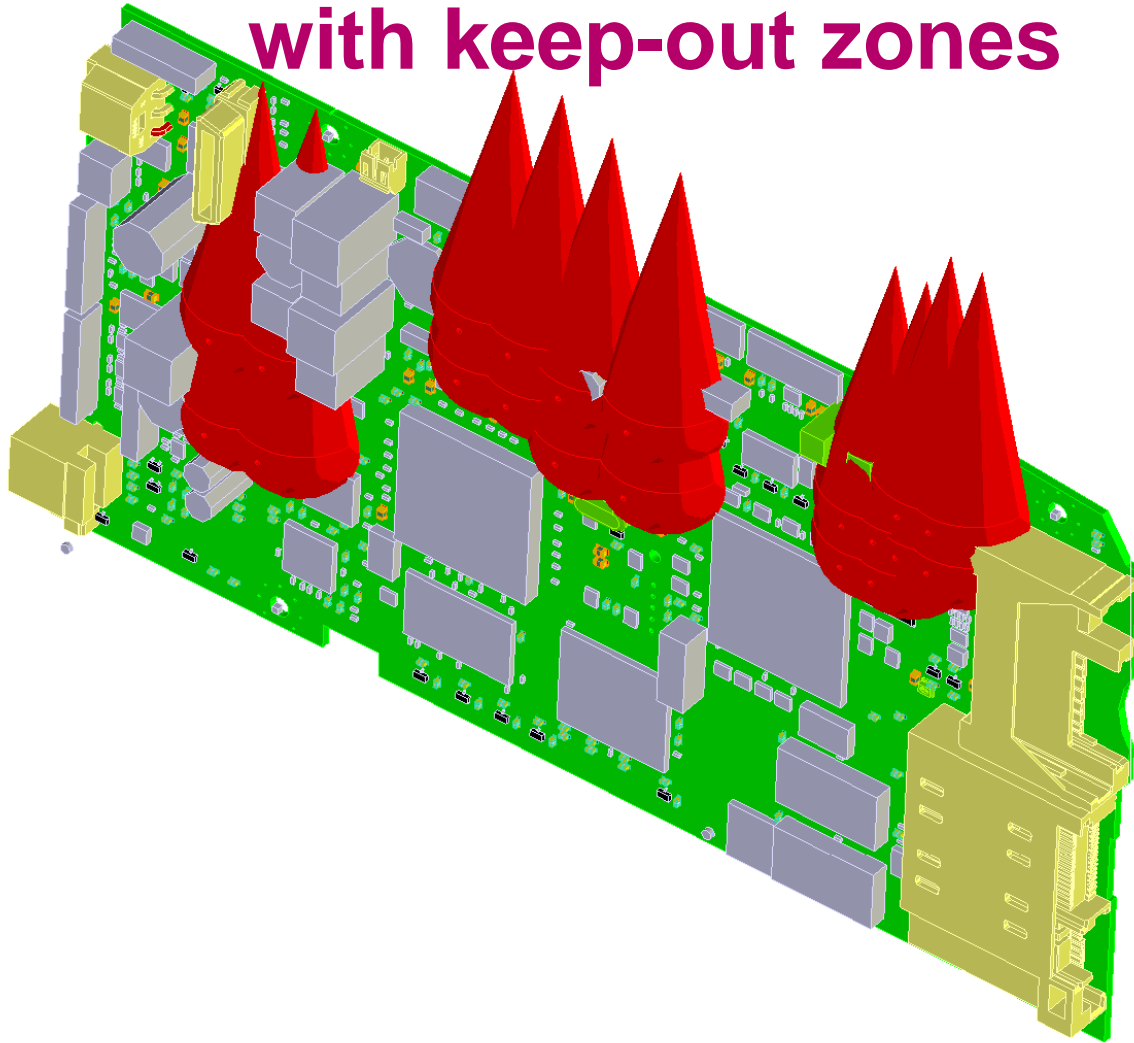


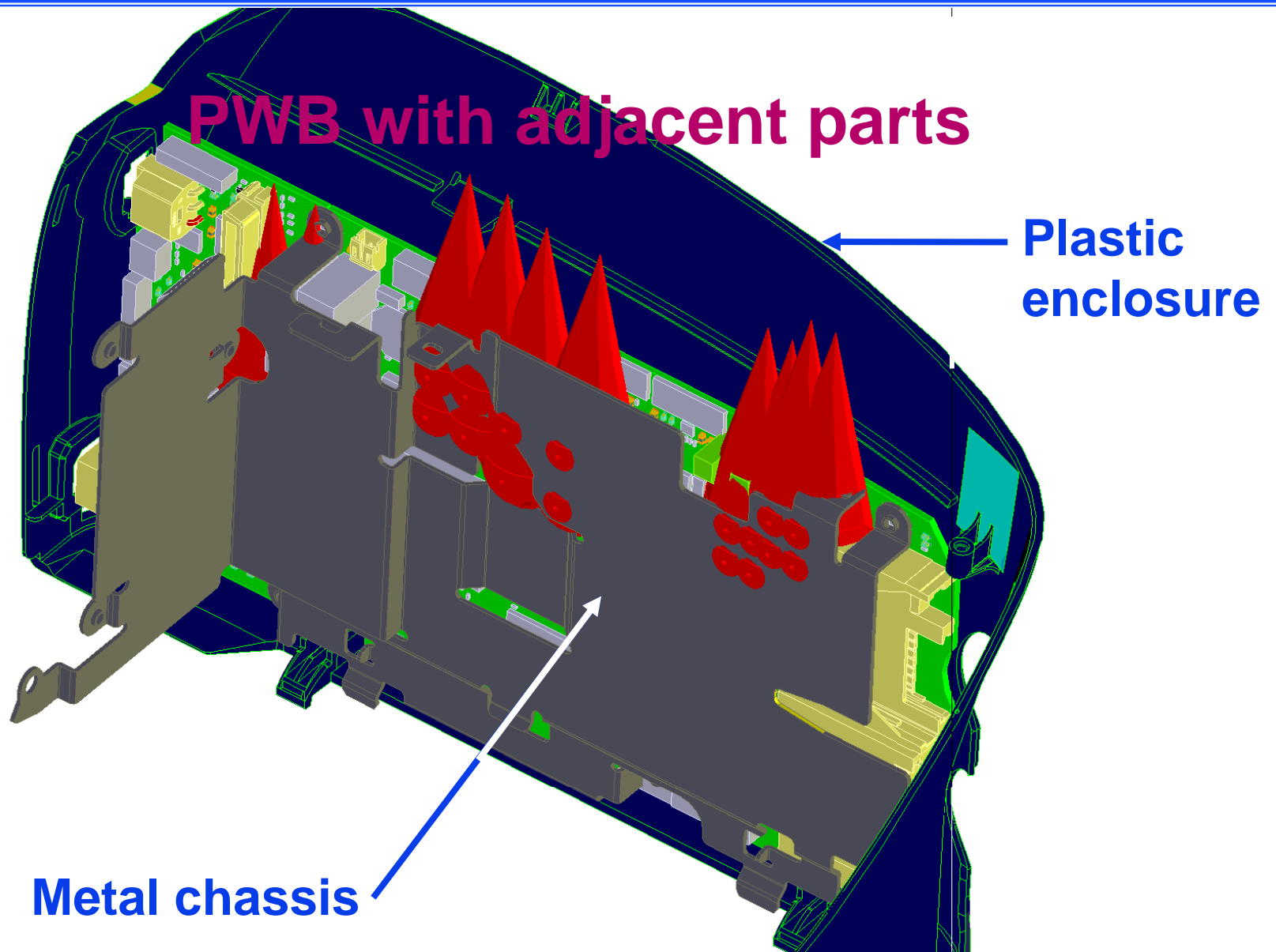
IGNITION SAFEGUARDS

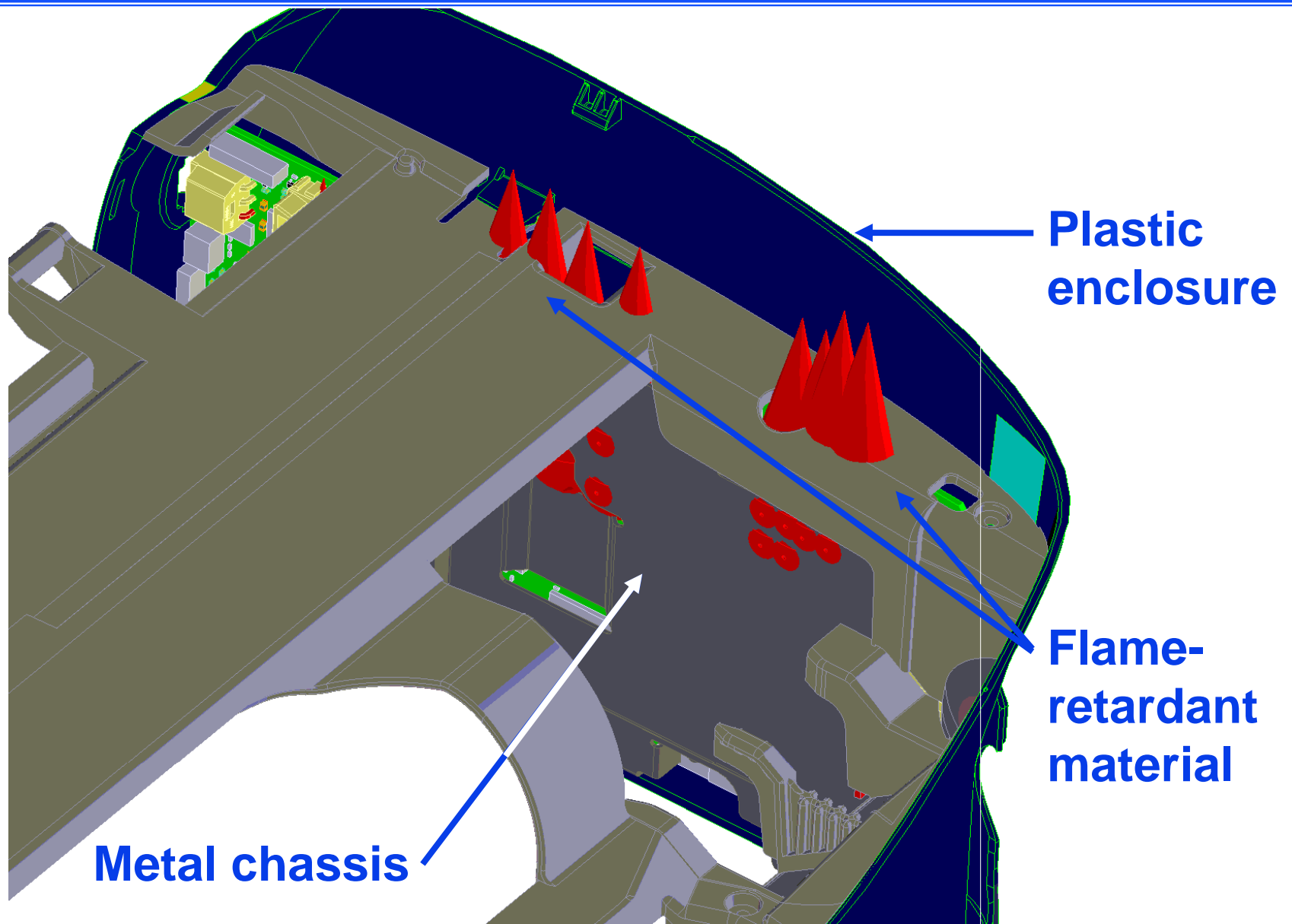
keep-out zone

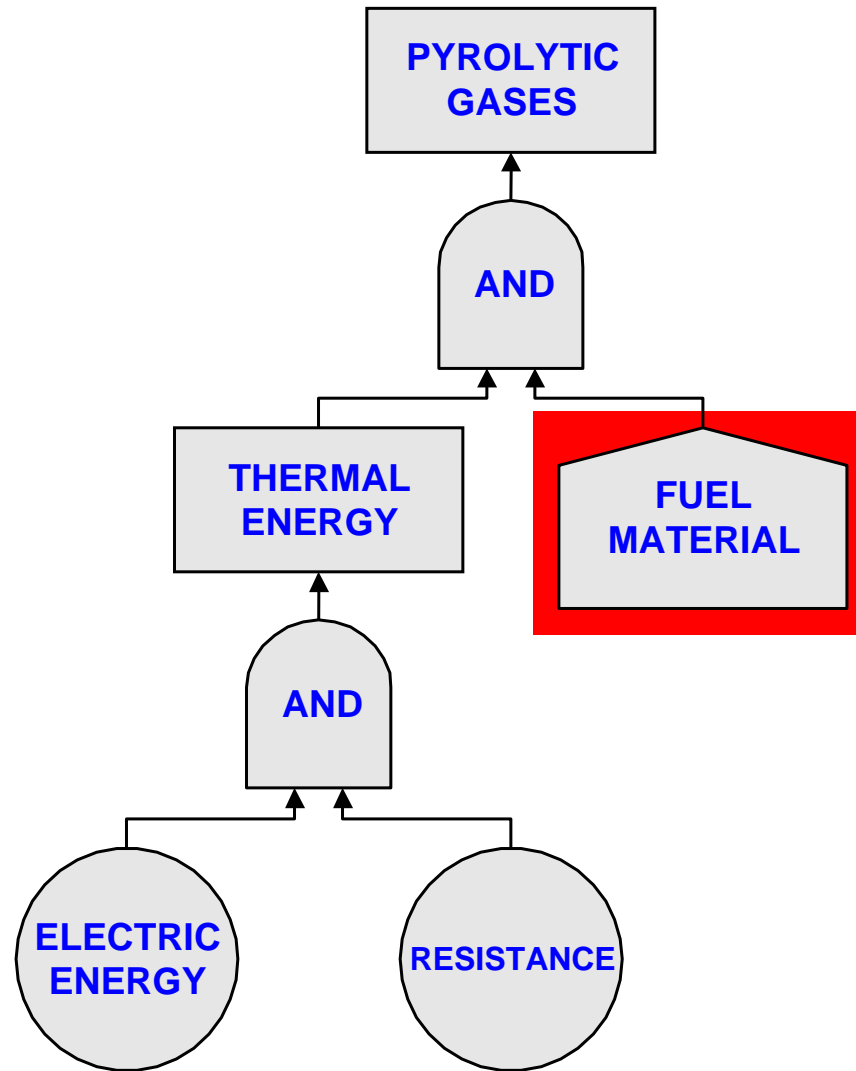


Power dissipating devices with keep-out zones



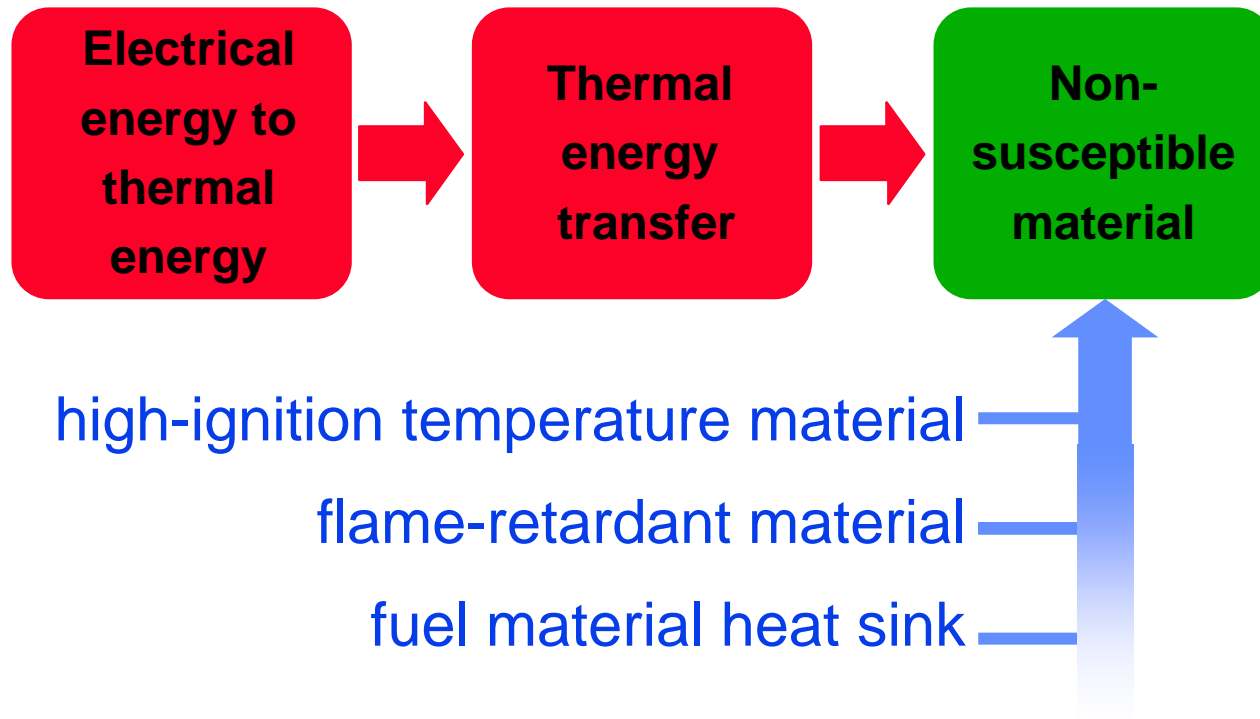






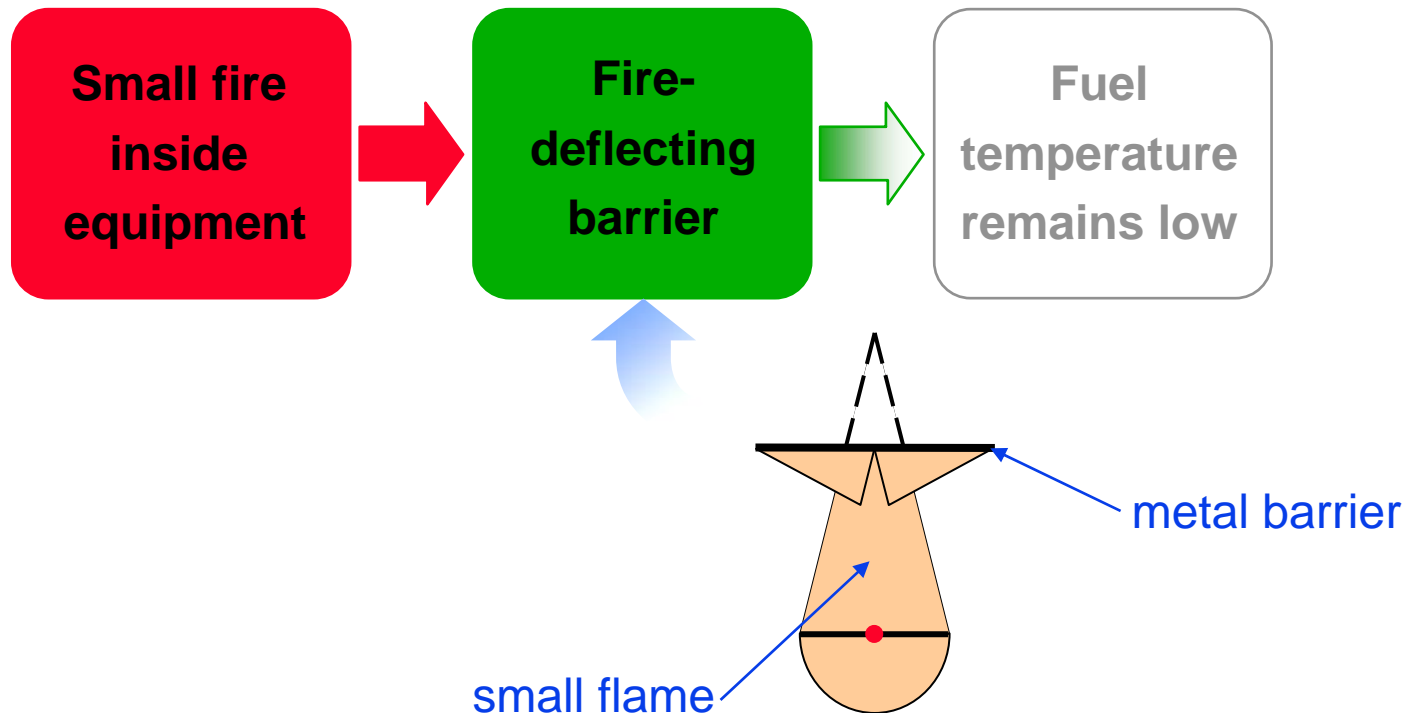
IGNITION SAFEGUARDS

Non-susceptible material:



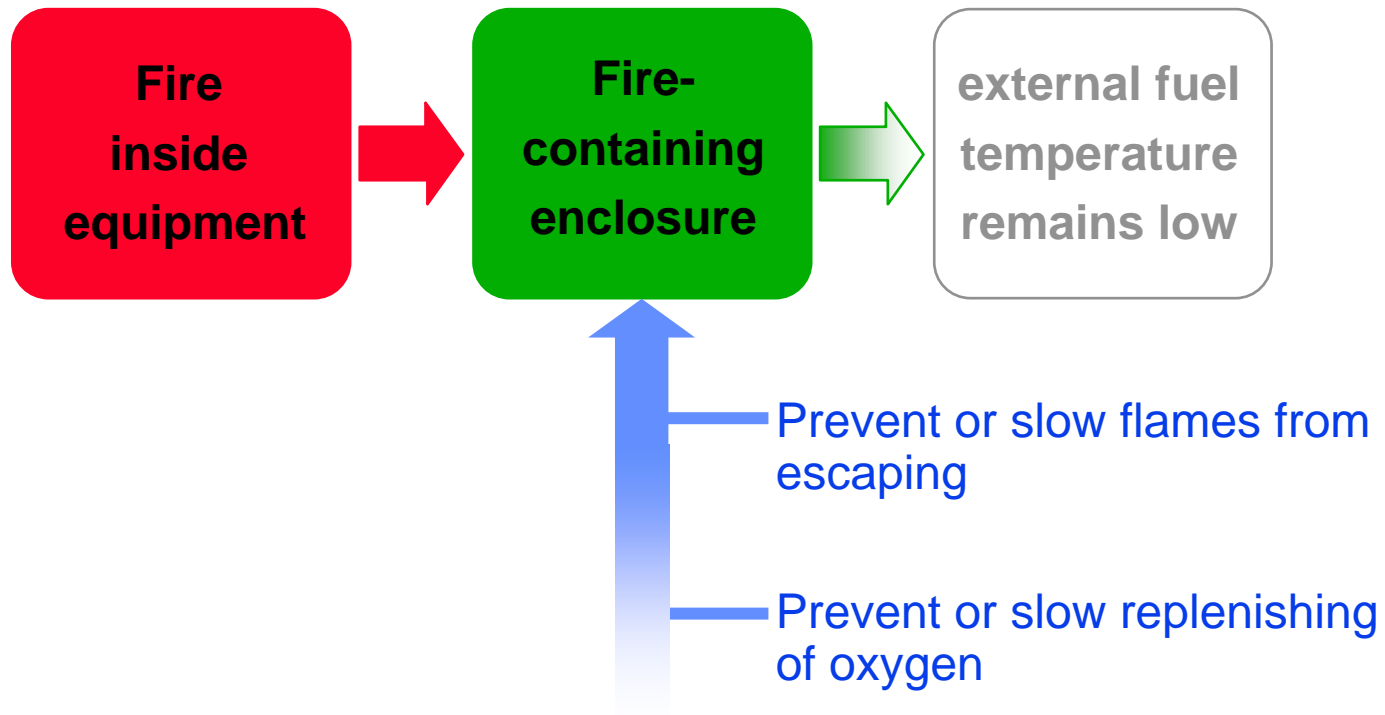
SPREAD-OF-FIRE SAFEGUARDS

from the PIS



SPREAD-OF-FIRE SAFEGUARDS

from within the equipment



The fire-containing enclosure

Video Demonstration

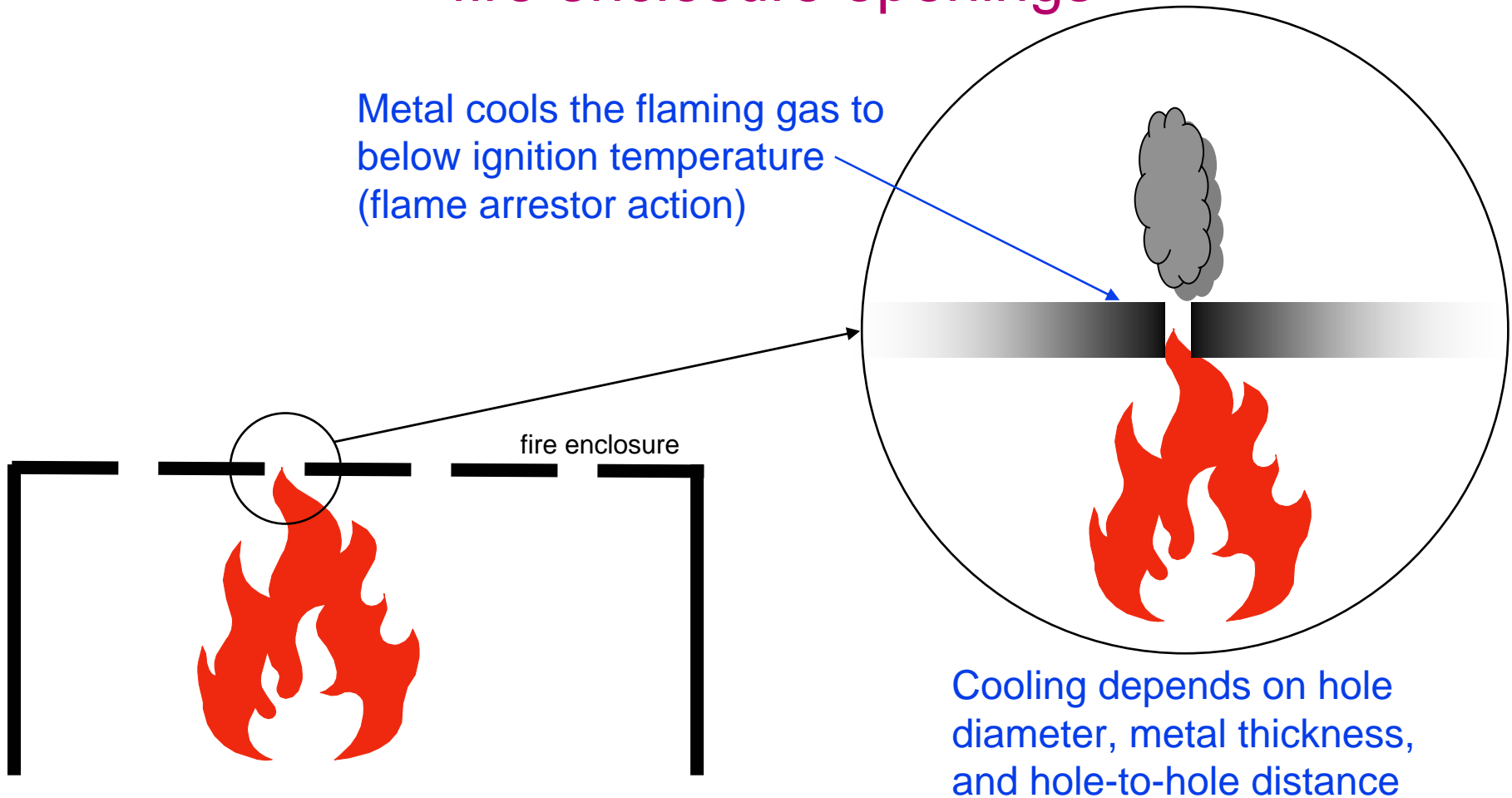
4-mm diameter holes
5-mm diameter holes

What is the mechanism that prevents spread of fire through enclosure openings?

6:21 minutes
06:24 – 12:45

SPREAD-OF-FIRE SAFEGUARDS

fire enclosure openings



end

safeguarding against electrically-caused fire

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