

# **Durability of solar cooking tubes**

## **- some field trials and observations**

**Stewart Maclachlan & Dave Oxford**



# Warning:

Solar cooks may find some of the following images distressing



**Why do they break?**



Why do they break?

Because people drop them?

# 'Rand' tube from US – October, 2014











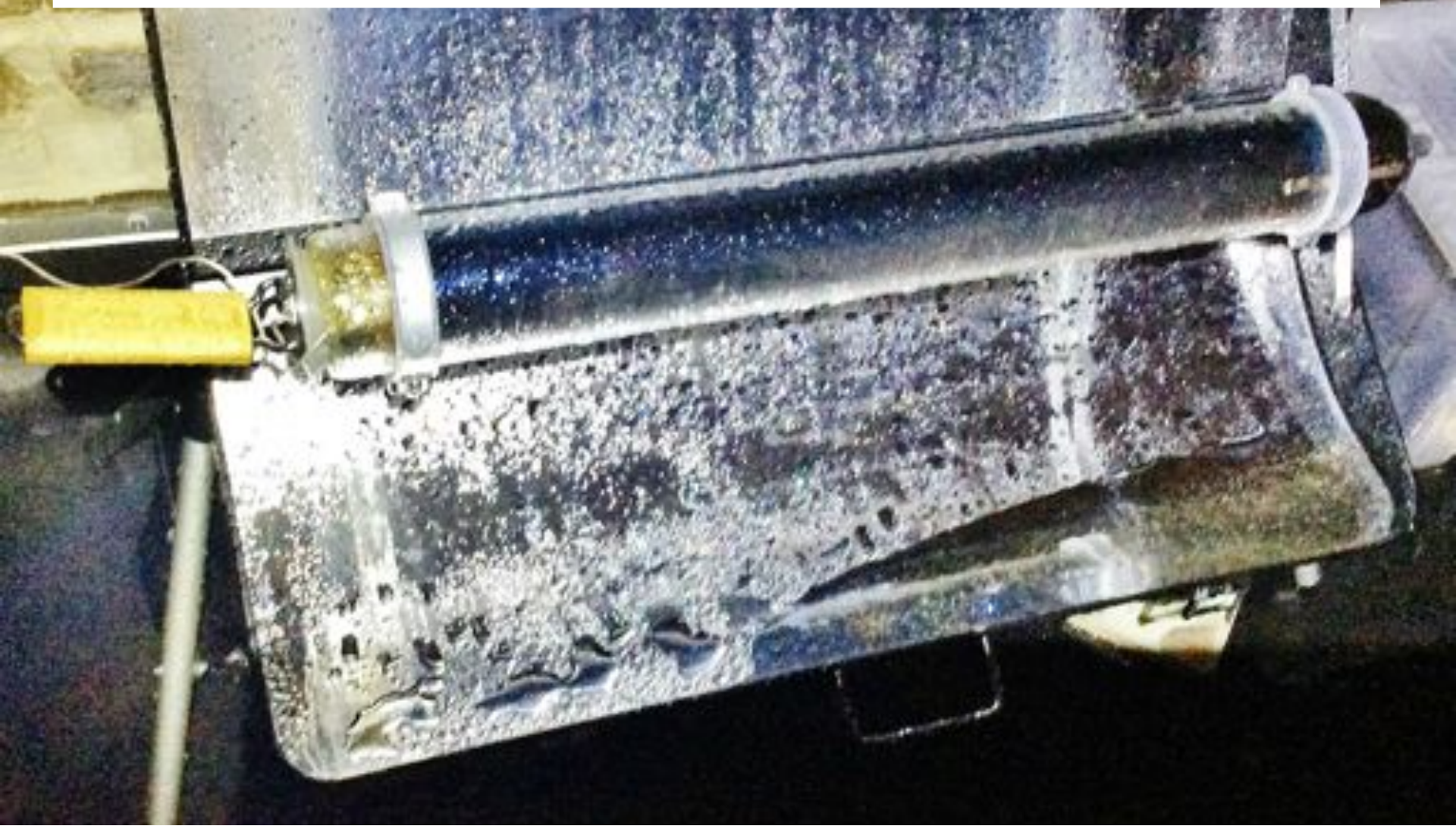
# SLiCK UK Shipping breakages

Item	Source	Number	Intact	Broken
GP Sci	USA	1	1	0
Rand	USA	4	4	0
SM70	China	2	1	1
SM125	China	2	2	0
SM70	China	2	1	1
SM70	China	100	100	0
SM70	China	20	20	0

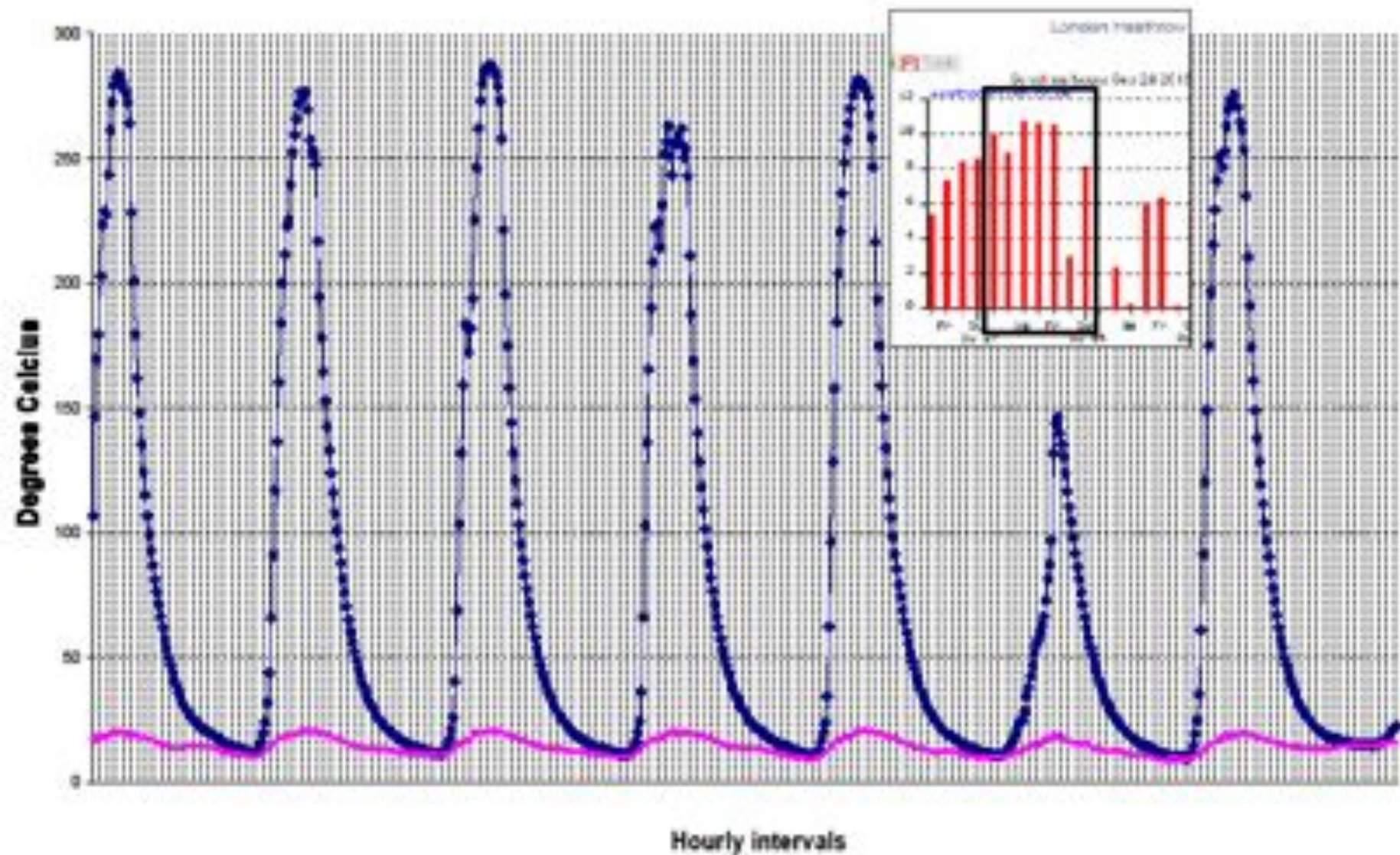
Why do they break?

Because they get too hot?

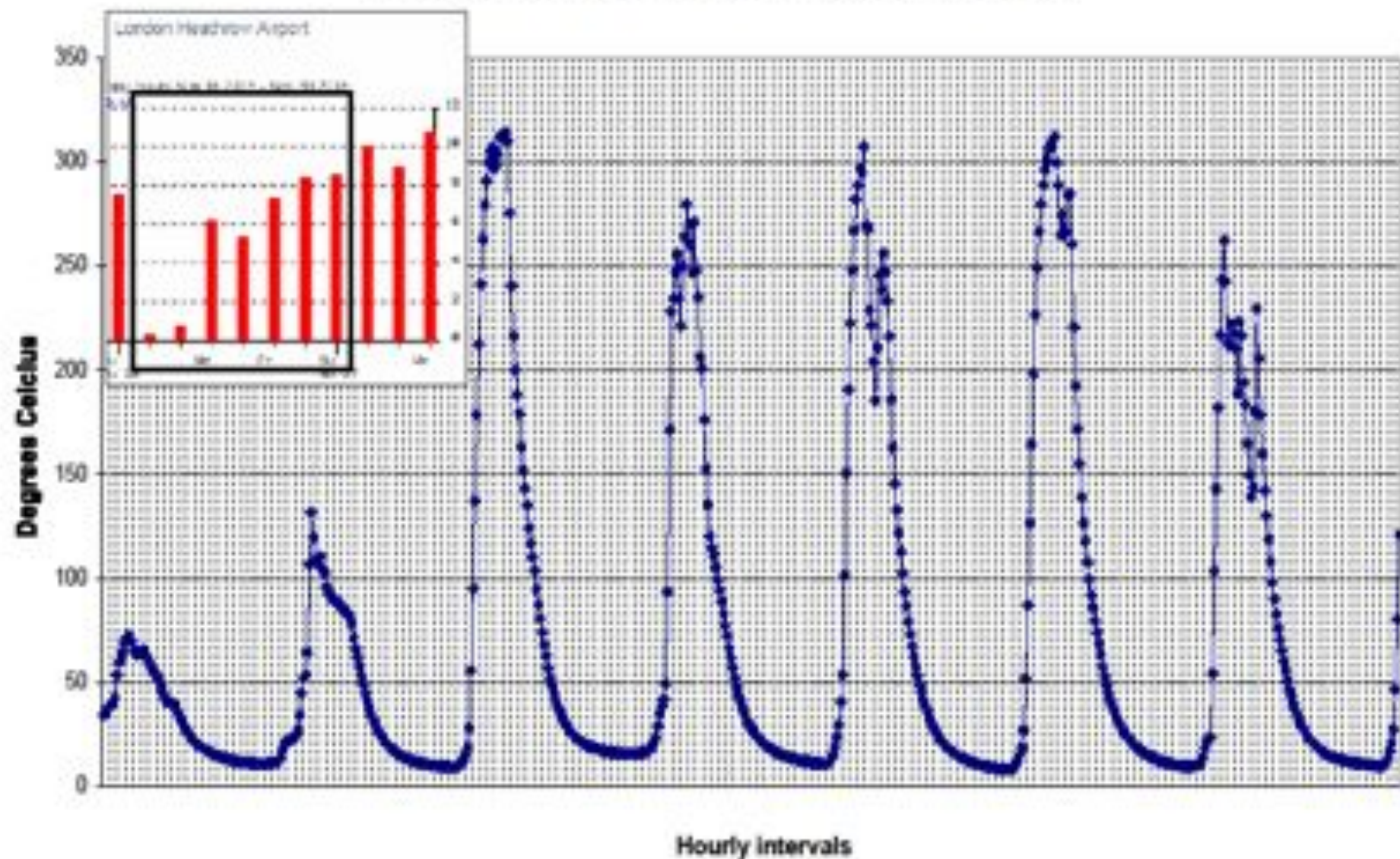




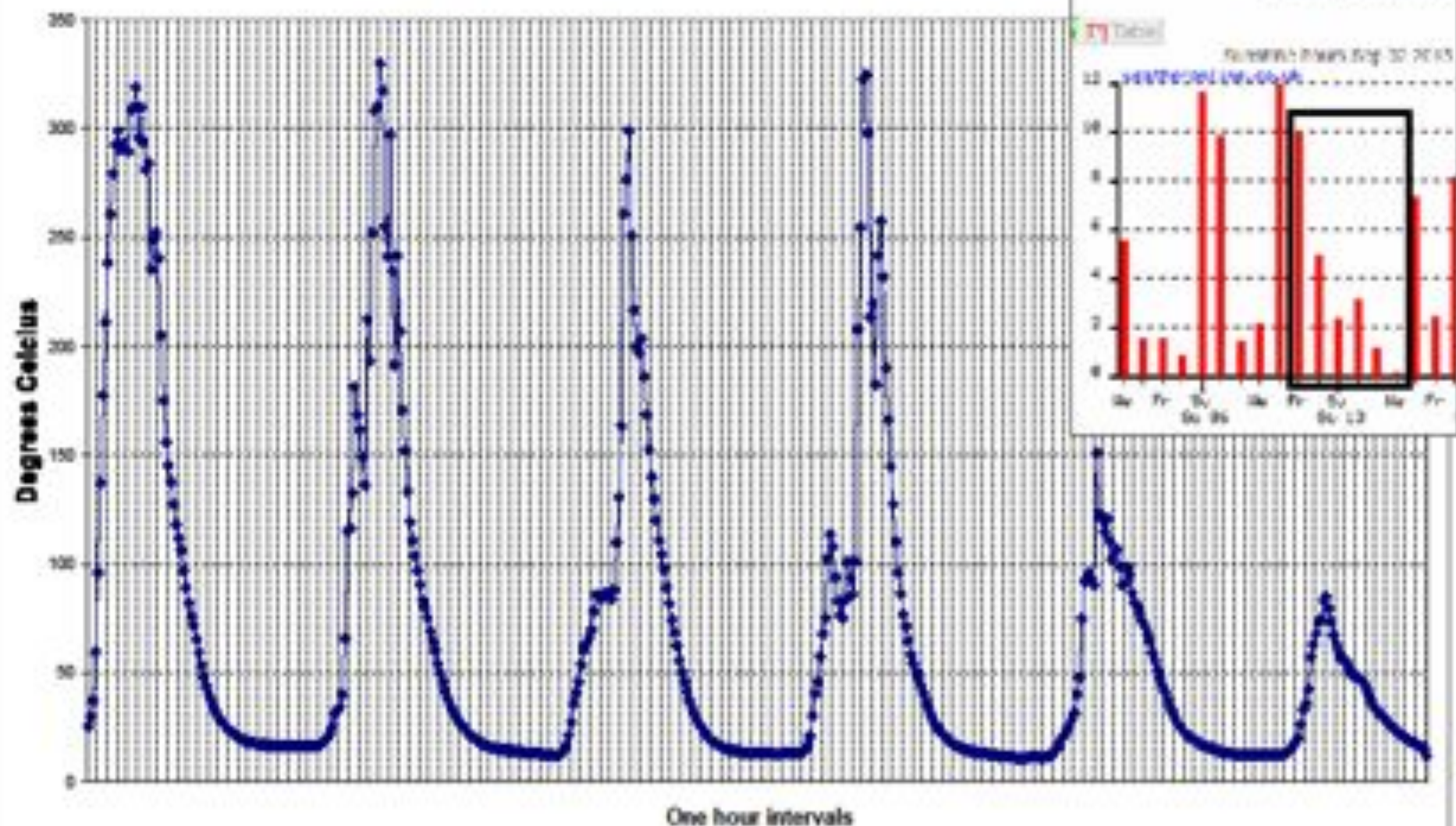
Air temperature inside an SM70 facing due south (no tracking) loaded with 1 kilo stainless steel cutlery between 28th Sept and 4th October



Air temperature inside an SM70 facing due south (no tracking) loaded with .5 kilos stainless steel cutlery between 21st Sept 2015 and 27th Sept 2015



Air temperature inside an SM70 facing due south (no tracking) loaded with .12 kilos stainless steel cutlery between 11th Sept 2015 and 16th Sept 2015





Published figures –

# ***Corning* borosilicate glass**

Temperature limits:

Normal Service: **230°C**

Extreme Service: **490°C**



Why do they break?

Thermal Shock?

# Borosilicate 3.3

$$\Delta T = \sigma_f / \alpha E$$

- $\Delta T$  - temp. difference
- $\sigma_f$  - fracture stress
- $\alpha$  - Coeff. expansion
- $E$  - Young's modulus

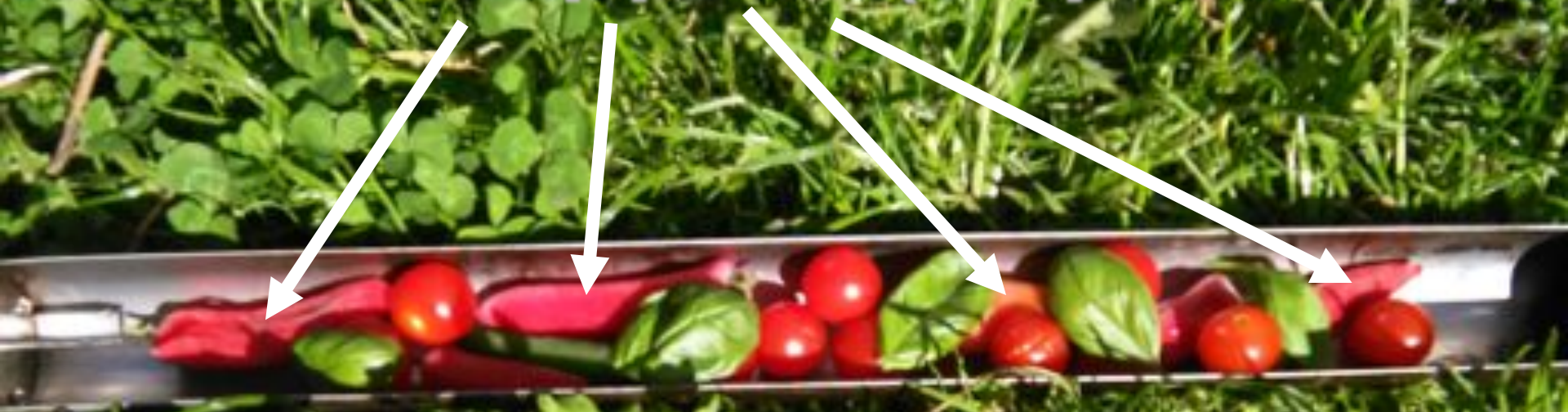


**183°C**



**Source:**  
***TopChef***  
a TV  
Cooking  
Competition  
in the USA

# Frozen Peppers (Capsicum)



(at ? -10° C)



Why do they break?

Piston Peril?







Thock!





Why do they break?

Mechanical Overload?





# Summary & Conclusions

# SLiCK UK in-service breakages

Item		Source	Cause?
SM125	– (1)	China	Overfilling – Piston
SM70	– (1)	China	Thermal shock
Rand	– (1)	USA	Overpressure
Rand	– (2)	USA	Mechanical overload
SM70	– (2)	China	Piston
SM70	– (3)	China	Piston
SM70	– (4)	China	Mechanical overload

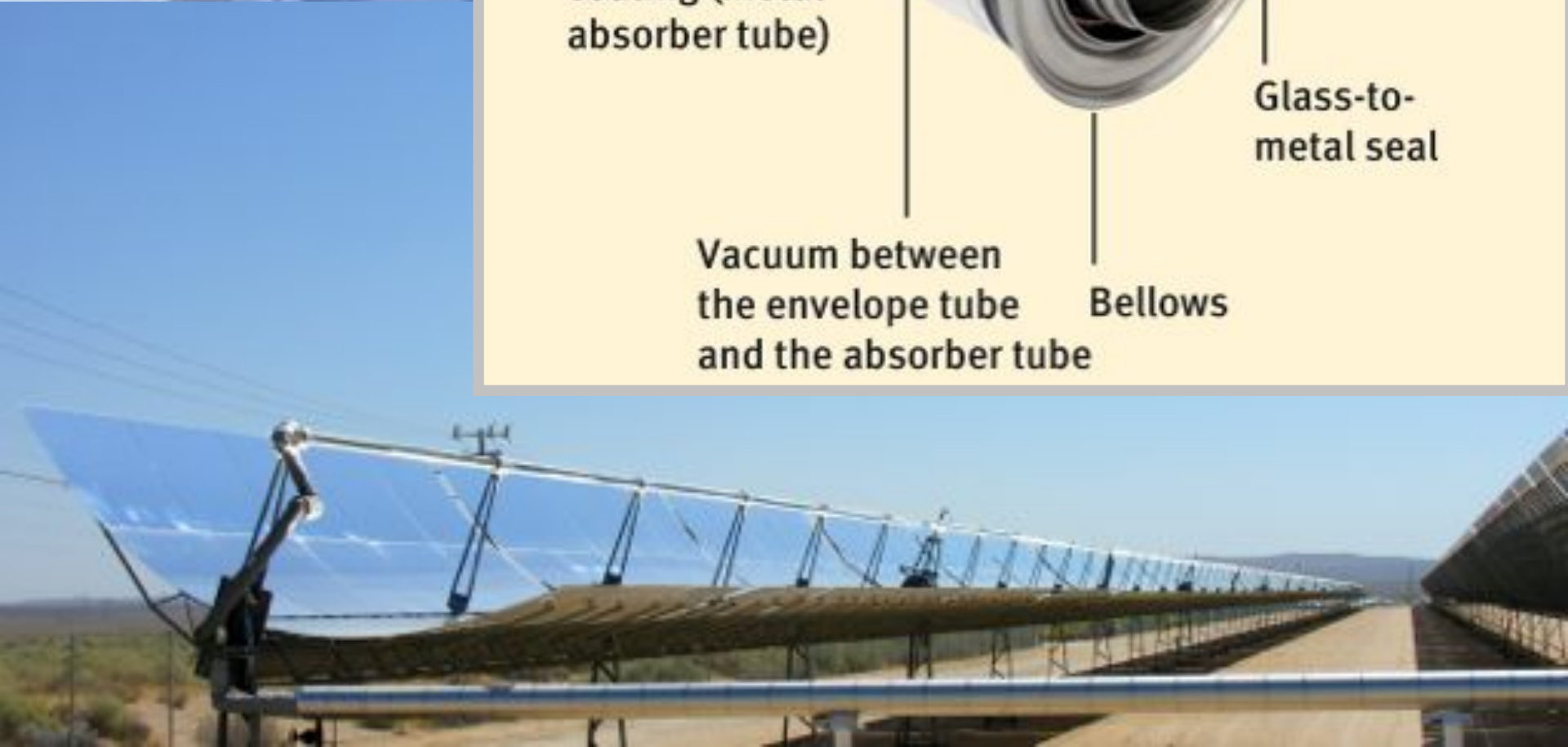
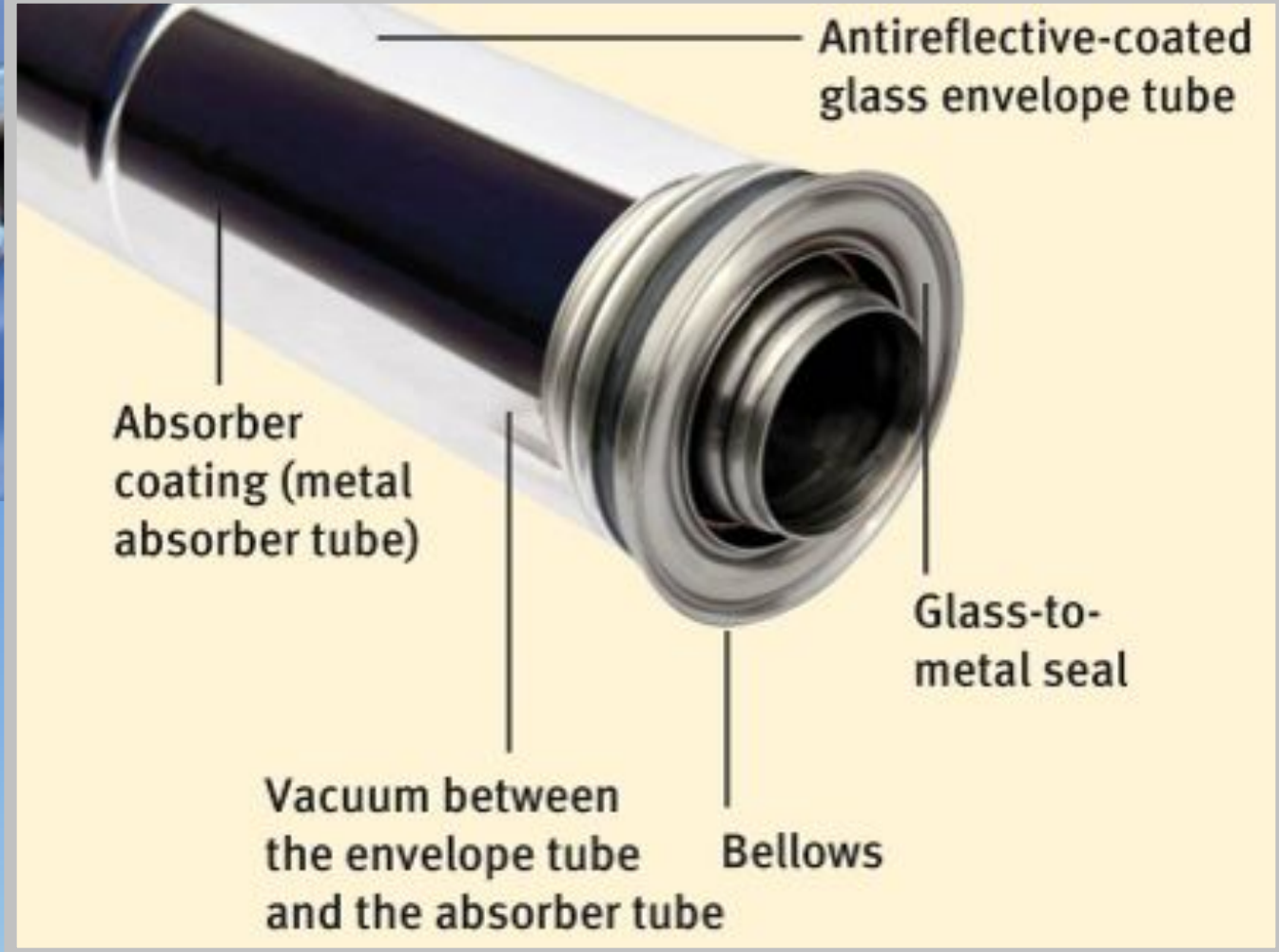


# Four lessons:

- Expect some shipping casualties.
- High temperatures do not destroy tubes.
- Reduce thermal gradients.
- Avoid blocking the tube.

# The future?

- Is it worth persevering with tubes?
- What about a re-design?





**‘ ..126mm diameter tube. All the inner tube is made of stainless steel 304-2B ‘**

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