

Taking the Next Step: Moving from Observation to Action

PG&E & The New Breaker SF₆ Leak Study

Sven Thesen

Senior Environmental Consultant

Pacific Gas & Electric Company

415/973-1048

sxtg@pge.com



*Pacific Gas and
Electric Company*[®]

Collected Data

- 537 Breakers installed 1998-2002;
- 41 had at least one “leak” alarm;
- 78 alarm (repeaters)

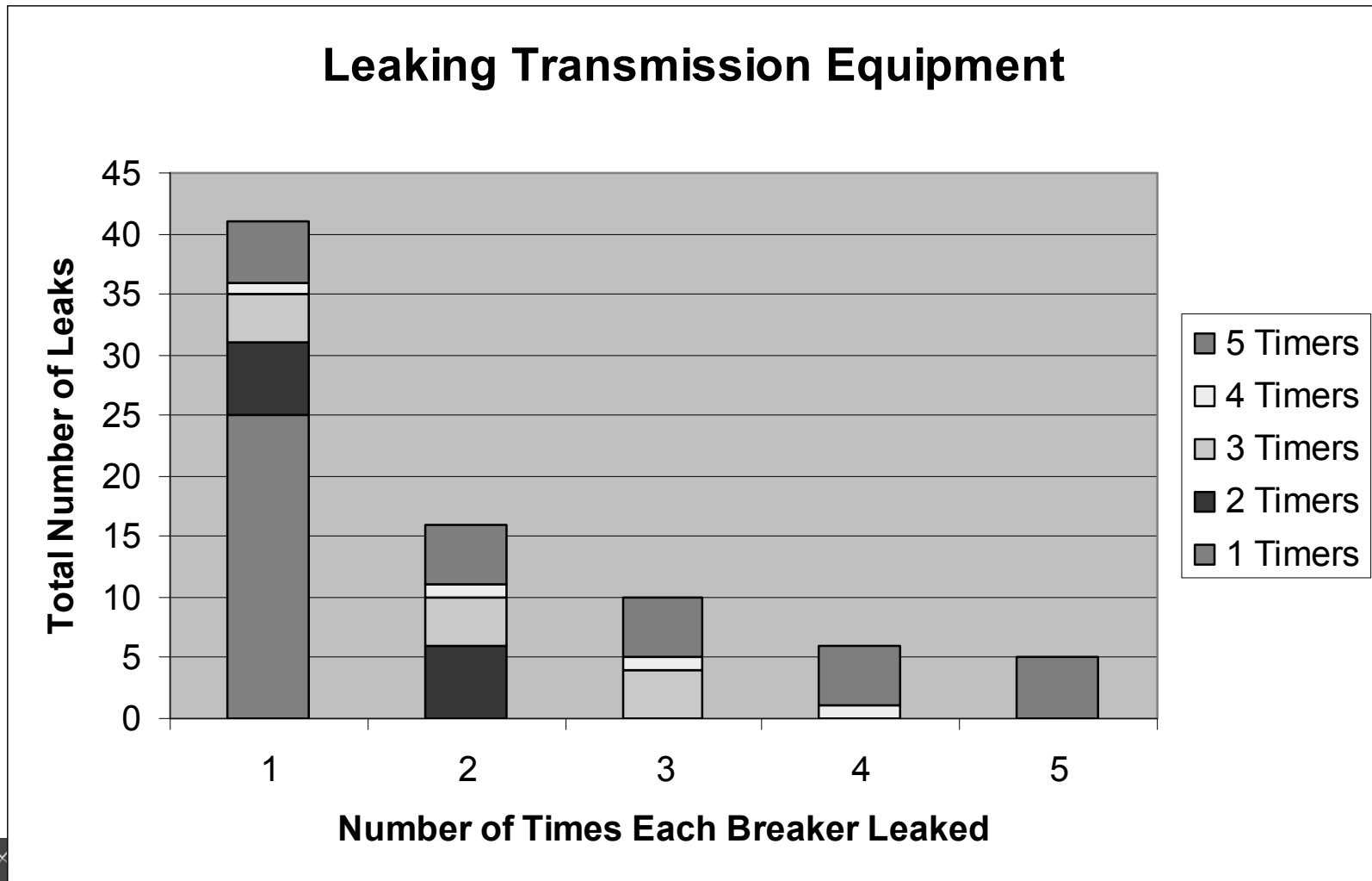
Living in a new paradigm



*Pacific Gas and
Electric Company®*

41 Leakers

- Less than 8% leak
- ~1/3 repeat or new



Function (Leak) Detectors

- All breakers charged MY 1998-02 to ~80 psi at ~68 F SF6,
- Some utilities consider this a density of 100%;
- Alarm (leak determined) triggered by “true” drop of 10 psi or 10% drop by density monitor.



*Pacific Gas and
Electric Company®*

Density Monitor/ Function Detector

- Measures ambient breaker temperature and pressure;
- Calculates real time pressure or density;
- “Adjusts” for pressure and temperature & compares to full breaker pressure/ density;
- Accuracy: ~ ± 2 psi, $\pm 2\%$.



*Pacific Gas and
Electric Company®*

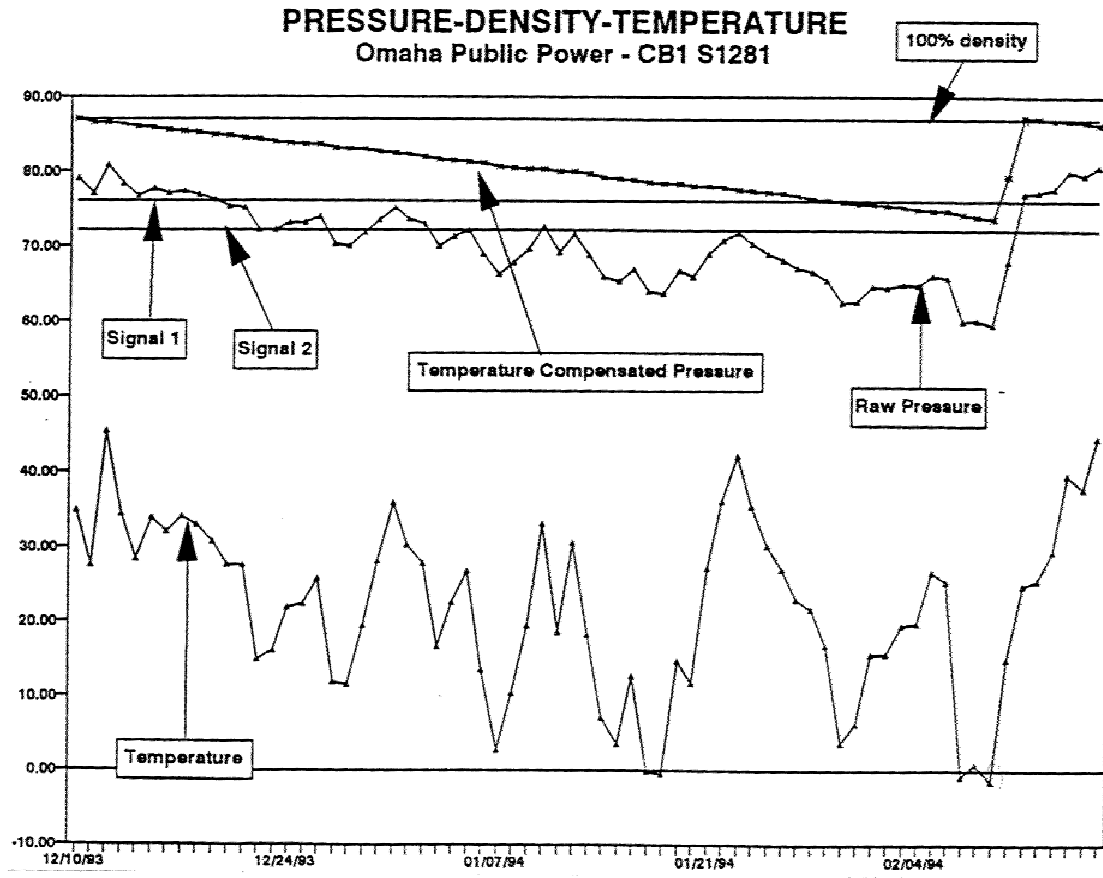
Eureka Moment

- Either “Leak” or Not
- If leaking, why wait so long to alarm?



*Pacific Gas and
Electric Company®*

Eureka Moment



**Pacific Gas and
Electric Company®**

10 psi leak?

Use Ideal Gas Law

$$PV = nRT$$

P = pressure

V = Volume

n = moles

R = gas law constant

T = temperature

- $PV = nRT$ @ full charge
- Known: P, n, R & T
- Calculate V
- Drop P by 10 psi
- Hold V & T constant
- Calculate new n



*Pacific Gas and
Electric Company*[®]

10 psi leak?

- 10 psi drop \approx 10% SF6 loss
- 5 psi drop \approx 5% SF6 loss

@ 80 psi initial charge & holding T constant
~70 F



*Pacific Gas and
Electric Company®*

10% Density Leak?

Density = mass/volume

V = Breaker Volume (Constant)

m_f = mass SF_6 at full charge

m_t = mass SF_6 at time t

% Density at time t = $(m_t/V)/(m_f/V) = m_t/m_f$

10% Density Loss = 10% SF_6 loss



*Pacific Gas and
Electric Company*[®]

Implications:

Large breaker: 450 pounds SF₆

- 10 psi or % set point \approx 45 lb SF₆ loss
- 5 psi or % set point \approx 23 lb SF₆ loss

Why wait to address the leaker?

(especially as it still may be under warranty)



*Pacific Gas and
Electric Company*[®]

Implications:

Changing alarm set-point from 10 psi or % to 5 psi or % has the potential to half the breaker leak rate.



*Pacific Gas and
Electric Company®*

Other Potential Issues:

- Some thermocouples are not positioned properly & may give false readings;
- Temperature unit confusion in setting density monitor;
- Pressure sensor connections may leak SF₆;



*Pacific Gas and
Electric Company*[®]

Going Forward:

PG&E to change density monitor set point on a few new large breakers.



*Pacific Gas and
Electric Company®*