

## **EIGHTH PART**

# PROPORTIONAL SAMPLING

Theory and Practice

# PURPOSE AND PRINCIPLE OF PROPORTIONAL SAMPLING

**PROPSAMP** is designed to estimate the mass of a lot of flowing material. Sampling theory shows that the mass  $M_S$  of a correct sample  $S$  is proportional to the mass  $M_L$  of the lot  $L$  and that the sampling ratio  $M_S / M_L$  can be estimated easily and accurately. In addition, the sample  $S$  can be used for all kinds of assays or tests.

# JUSTIFICATION OF PROPORTIONAL SAMPLING

The weighing expert H. Colijn states that « The actual plant performance of belt (or nuclear) scales does not always measure up to the claims of the manufacturer or to the expectations of the operator. Instead of the  $\frac{1}{2}$  % accuracy ... claimed ... 10 % is a more realistic figure ». This is in good agreement with our own experience.

# THEORY ♦ SAMPLING RATIOS

- TIME SAMPLING RATIO  $B_T$  :

Time during which lot **L** is diverted

$$B_T = \frac{\text{Time during which lot L is diverted}}{\text{Time during which lot L flows}}$$

When sampling is CORRECT and only then,  $B_T = P = \text{constant}$ .  $B_T$  can be estimated accurately ...

$$B_T = \frac{Q T_i}{T_L}$$

- **MASS SAMPLING RATIO  $B_M$  :**

$$B_M \equiv \frac{\text{Mass } M_S \text{ of Sample } S}{\text{Mass } M_L \text{ of Lot } L}$$

Sampling theory shows that  $B_M$  is a random variable with mean ...

$$m(B_M) \equiv B_T \equiv m(M_S) \div M_L$$

and a very low variance. Hence ...

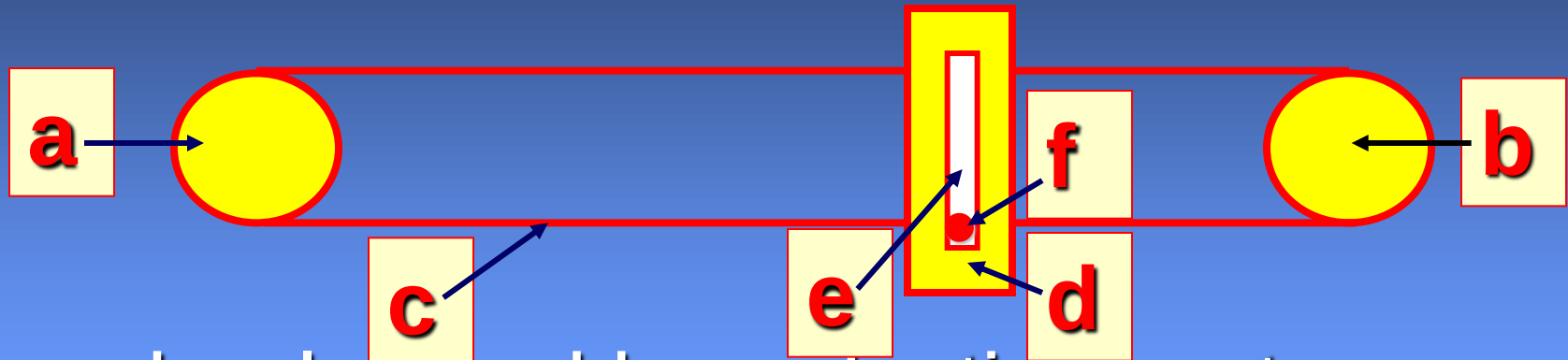
- **Estimate  $\text{est}(M_L)$  of  $M_L$  easy to compute**

$$\text{Est } (M_L) = M_S \div B_T$$

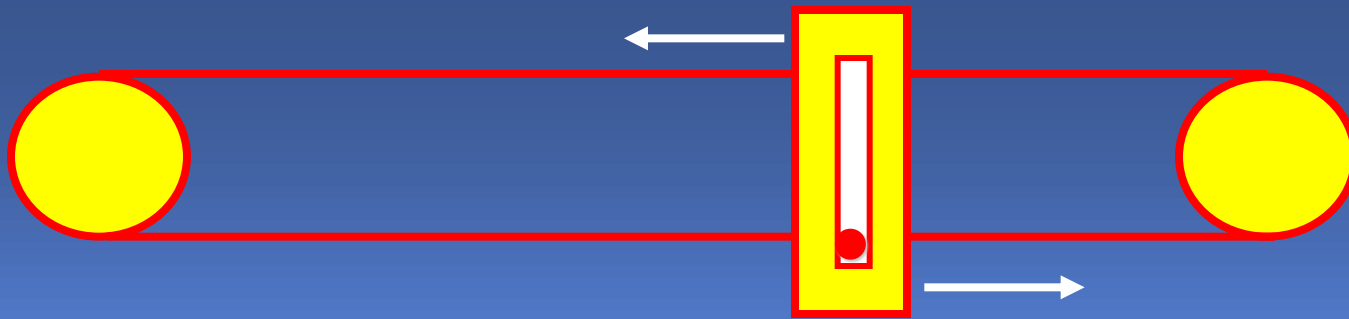
# PRACTICAL IMPLEMENTATION

- PREREQUISITE : Sampling must be HYPER-CORRECT. Probability P must be STRICTLY UNIFORM. Safety factors.
- SAMPLE MASS  $M_s$  can be measured by means of HIGHLY RELIABLE static balances accurately calibrated (no bias).
- TIME SAMPLING RATIO  $B_T \equiv Q T_i \div T_L$  can be ACCURATELY estimated.

# EXAMPLE ♦ THE CHAIN SAMPLER



- a** : wheel driven by reduction-motor
- b** : free wheel
- c** : endless chain driven by driving wheel
- d** : frame to which the cutter is attached
- e** : open slit
- f** : lug sliding along the slit **e**, driving the frame **d** and the cutter (not shown)



**C** : length of the endless chain

**W** : Internal cutter width, assumed to be uniform

**V** : cutter velocity, assumed to be uniform

**T<sub>i</sub>** : duration of **one** stream cut. Cutter takes **two** increments during **one** chain cycle

$$T_i = 2W \div C$$

**Q** : number of increments in sample S.

# ESTIMATE OF THE LOT MASS $M_L$

$$\text{Est } (M_L) = M_S \div B_T = M_S T_L \div Q T_I$$

$$\text{Est } (M_L) = M_S T_L C \div 2 Q W$$

$M_S$  : weighed by means of a static balance

$T_L$  : measured,

$C$  : measured,

$Q$  : known,

$W$  : measured (beware of wear).

# PRACTICAL IMPLEMENTATION

- **INDUSTRIAL SCALE** : since 1981 proportional sampling is used by Rustenburg Platinum Mines (South-Africa) first world producer of platinum and associated metals, to calibrate the nuclear scales installed originally and providing unreliable results. Thanks to PropSamp, the metallurgical balance is now satisfactory. Lots of money at stake in Pt-Pd industry !

- **PILOT PLANT VARIANT** : The principle of this variant consists in warranting the same unknown Time Sampling Ratio  $B_T$  to all streams of the plant : feed, concentrate(s), tailings, and other by-products.

The set of sample masses and the set of lot masses are homothetic. The metallurgical balance can be directly computed from the sample masses or proportions.

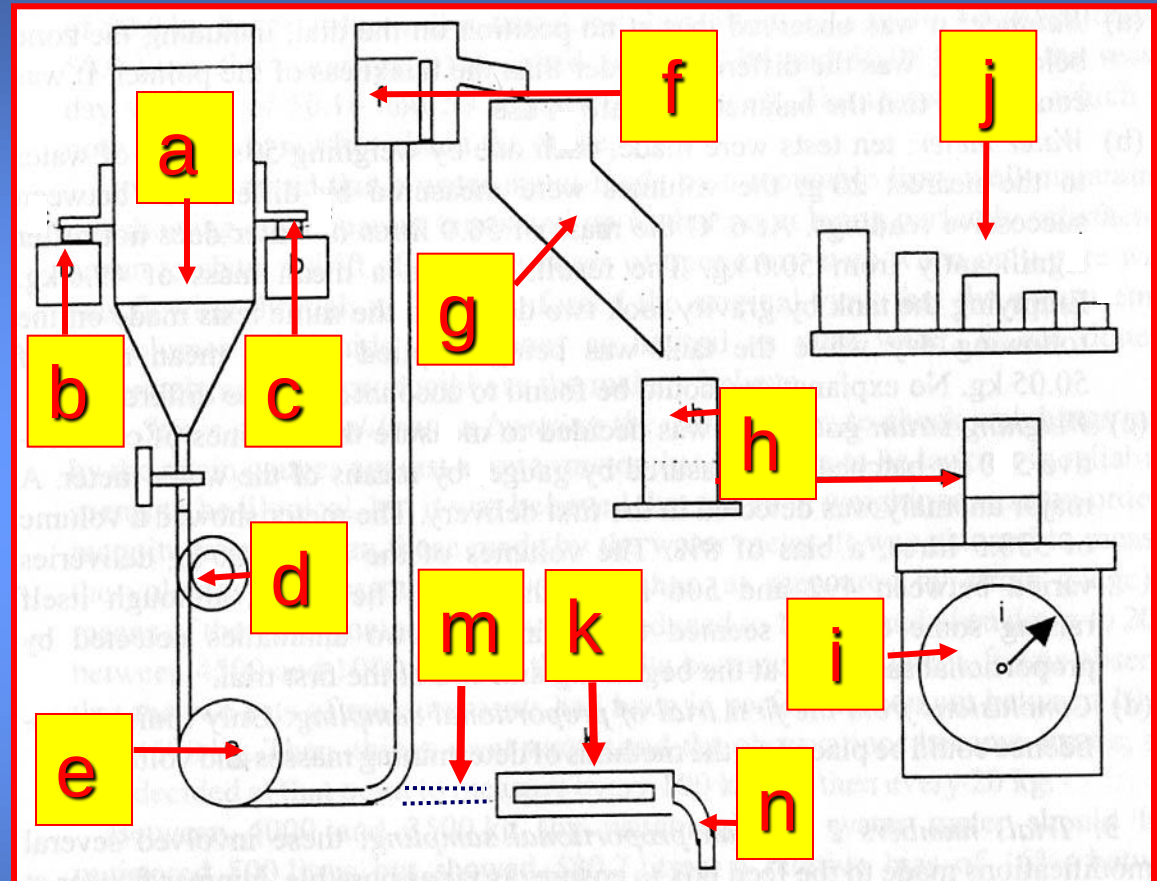
Successfully implemented at BRGM (French Bureau of Mines, Orleans).

## EXPERIMENTAL « CHECK »

In 1984, a potential **PROPSAMP** utilizer asked us to carry out an experimental check in his own pilot facilities, that were working to everybody's satisfaction, utilizing a system of strain-gauges to measure the masses involved. We carried out a series of tests in the plant described on the next slide. The idea was to test **PROP-SAMP** against the strain-gauges assumed to provide reliable measures ...

# EXPERIMENTAL FACILITY

- a : 10,000 liter tank
- b : ring girder
- c : 3 strain-gauges
- d : flexible loop
- e : centrifugal pump
- f : feeder box
- g : transverse cutter
- h : several 60 liter containers
- i : 60 kg balance
- j : sand standard weights
- k : water meter
- n : drainage channel



◆ m : by-pass to water-meter

The outcome of the test was quite different from what was expected. Thanks to **PROPSAMP**, we disclosed that the weighing system was heavily biased, as well as the water-meter implemented to calibrate the gauges !

## **PROPSAMP WAS ADOPTED !**

Wherever it has been implemented for the last 20 years, **PROPSAMP** has shown how reliable were the results it provided.

# CONCLUSIONS

Unfortunately, **PROPSAMP** is too simple and too cheap to retain the manufacturers' attention at a time when utilizers believe in sophistication and high cost.

Fortunately for its future, clever utilizers such as the South-African **Rustenburg Platinum Mines** and **BRGM's pilot plant** showed, among others, how reliable **PROPSAMP** could be, as compared to all other methods !

Last but not least, in addition to reliable masses, **PROPSAMP** also provides highly representative samples on which all kinds of assays and tests can be performed.

In a single operation, **PROPSAMP** provides all elements required by most utilizers. **It is cheap and reliable** when adequately implemented

**PROPSAMP** is a tool for the 21st century. The author thanks you for forwarding the message to interested parties !