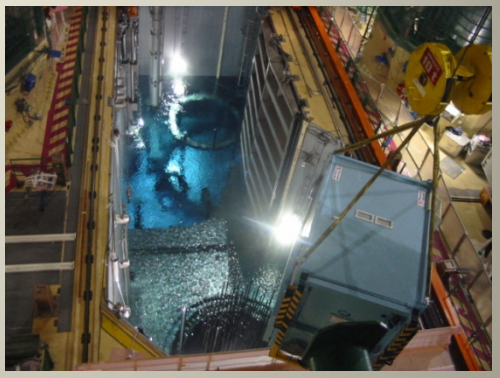
Bern 2014

SPHERE CAGES :



Securisation means

for PVU flexible hoses inlet

used for dynamic confinement in a tent

* PVU: Portable Ventilation Units

CONTENT

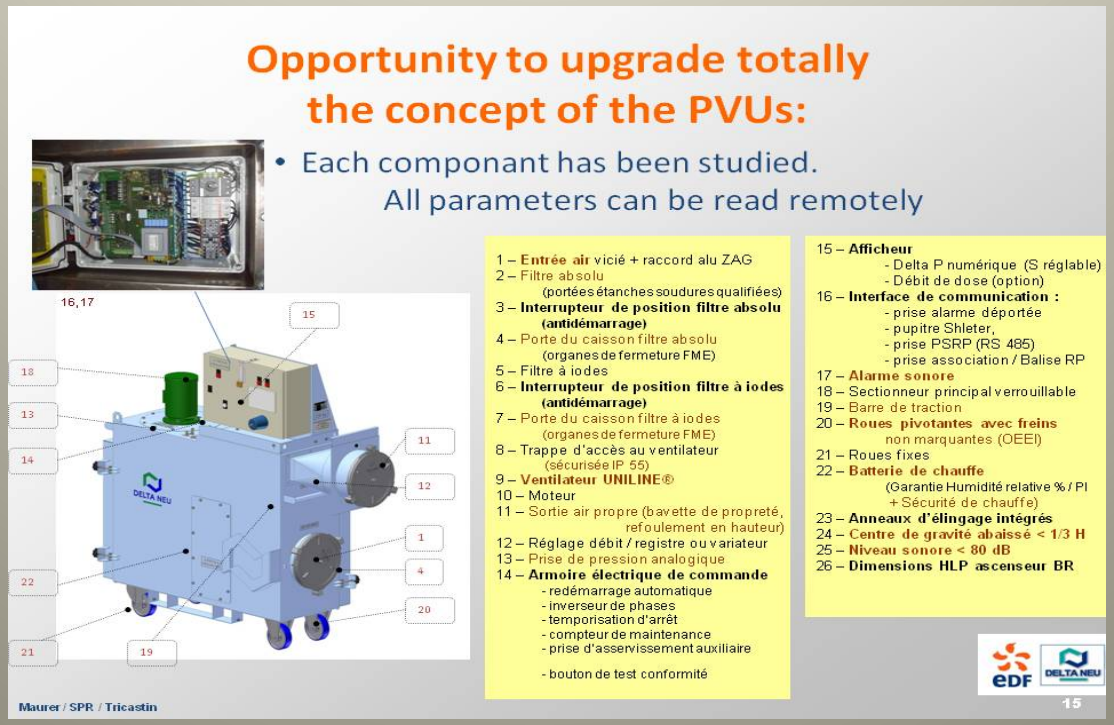
- **Context: OPERATING EXPERIENCE** (new functionalities of PVU and organisation as in-depth defense: presentation ISOE 2012 / Prague).
- **Problematic situation:** a single default mode in the field : clogging of suction hose. … consequences can be very important : security, fire, safety, radiological

- **From theory:**
  - Analysis of air velocity vectors at suction inlet
  - Clogging mechanism
- **To good practice:**
  - Sphere cage principle
  - Spherical opening surface
  - Drawings
- **Qualification tests:**
  - Theoretical qualification
  - Functional qualification
  - Operating experiences / Interviews
- **Synthesis:**

CONTEXT: Operating experiences (new functions of PVU and organisation as in-depth defense: presentation ISOE 2012 / Prague).

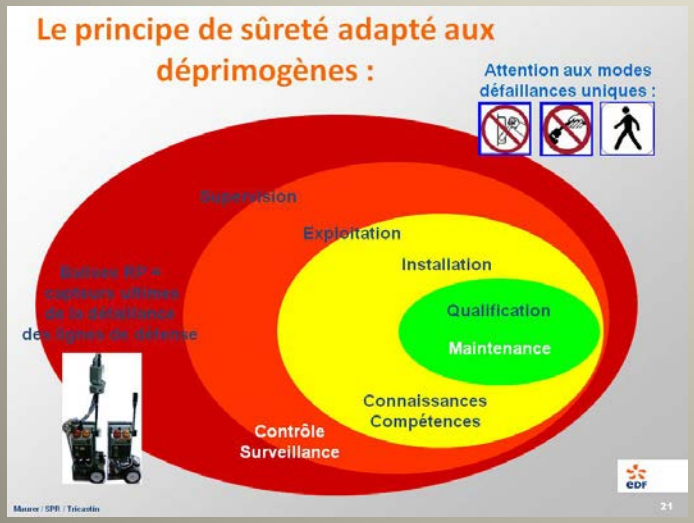
- **A new design:** Cyclair, Iodair, MEDGV, MEDPZR, MEDCP
- ➔22 technical specifications integrated

(New portable ventilation units comply with international operating experiences from events occured from 2008 to 2013)



Context: operating experiences

- A new organisation method: Cyclair, Iodair, MEDGV, MEDPZR, MEDCP



➔skill, install, control, follow up, alert, react, record…

➔Safety principles applied: many steps of preventive actions: 1 alarm = 4 actors

Problematic situation: a typical default mode in the field: clogging of suction hose…

Consequences can be potentially important:

- Radiological: Loosing of dynamic containment

Contamination and Iodine's dispersion outside working areas…

- Safety

Operator's fall with airproof ventilated suits,

- Safety and compliance

Lack of tent integrity,

Non-conformity (0.5 m/s into open surface)

- Fire

Lack of cooling (no air) → heating

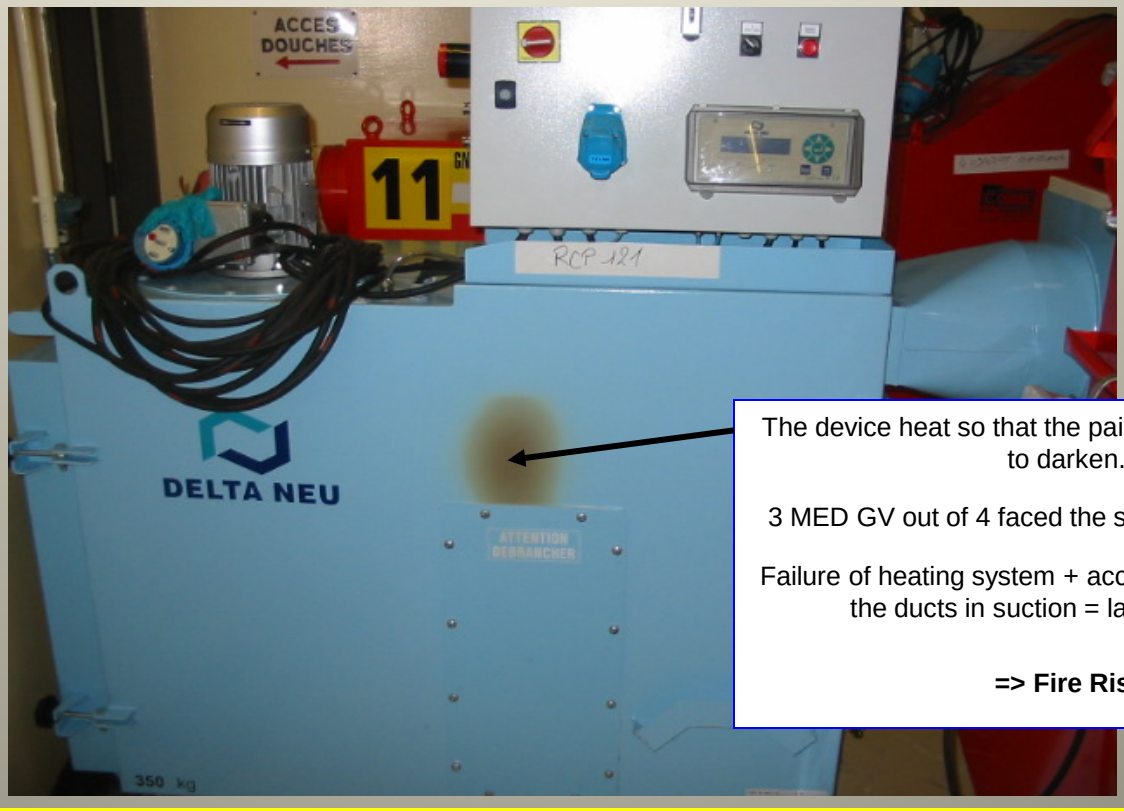
- Availability

Evacuation of the zone, planning affected

Flexible hose speed
*= **40 km/h !...***
*Traction strength = **20 kg …***

Fire: Some specific Portable Ventilation Units are equipped with High Efficiency Filter (aerosols) + Iodine Trap. Obstruction of the suction duct can also be the cause of overheating and thus fire can almost start. Heating system is used to increase temperature and ensure relative humidity lower than 40%, upstream iodine trap (OE Tricastin).

* *These events were concomitant with specific security failures and internal control of three MEDGV.*



The device heat so that the paint sheet metal began to darken.

3 MED GV out of 4 faced the same consequences:

Failure of heating system + accidental obstruction of the ducts in suction = lack of cooling.

=> Fire Risk

REX : Two evacuations of the reactor building during outages in 2011 and 2012: smoke detection ... Problem of MEDGV *(PVU used on Steam Generator Pipe Head during Eddy currents)*

Incandescent particles (insulation material) were projected from the outlet. • The material temperature (post filter and Iodine trap) increased by convection through the metal casing (separating the heating system of discharging casing). The temperature was high enough to carbonize and reach the point of ignition.

International OE: In Sweden, an event with a vacuum created a fire in the reactor building during a pressure test.

➔ ***The consequences: 9 months forced outage to re-compliance of the reactor building and all systems***

The origin of obstructions

Dynamic containment of working volumes is generally done by flexible hoses (airproof plastic duct reinforced with metal spires)

Foreign material: The working volume is often reduced and the working environment is constrained.

The presence of many equipment can affect efficiency

- → vinyl sheets,
- → Waste bags,
- → vinyl trims installed at the entrance and exit of the tent
- → etc …
- → Workers: airproof ventilated suits

Indirect effects = loss of tents integrity :
Analysis of Tricastin OE and EDF fleet shows that the obstruction of the inlet can have an immediate and violent mechanical effect because the duct can retract suddenly and can damage the tent

These cases happen sometimes recurrently during maintenance work.
Nevertheless, the risk of contamination spreading can be detected by measurements of atmospheric contamination with the installation of airborne monitors in the site.

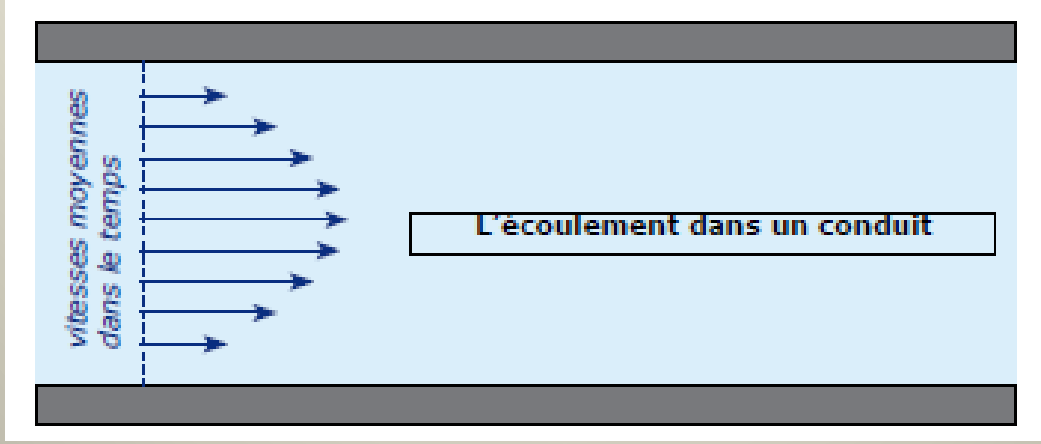
From theory: focus on an aerodynamic phenomenon

- Analysis of air velocity vectors at duct inlet
- The obstruction mechanisms

Open section: velocity in the duct section

The distribution of the velocity in the duct is not constant aerodynamically.

☐The maximum speed is at the center.



The average speed in the duct section is 5.89 m/s, in the center a maximum value is 18 m/s (duct diameter : 300 mm and air flow 3000 m^3/h).

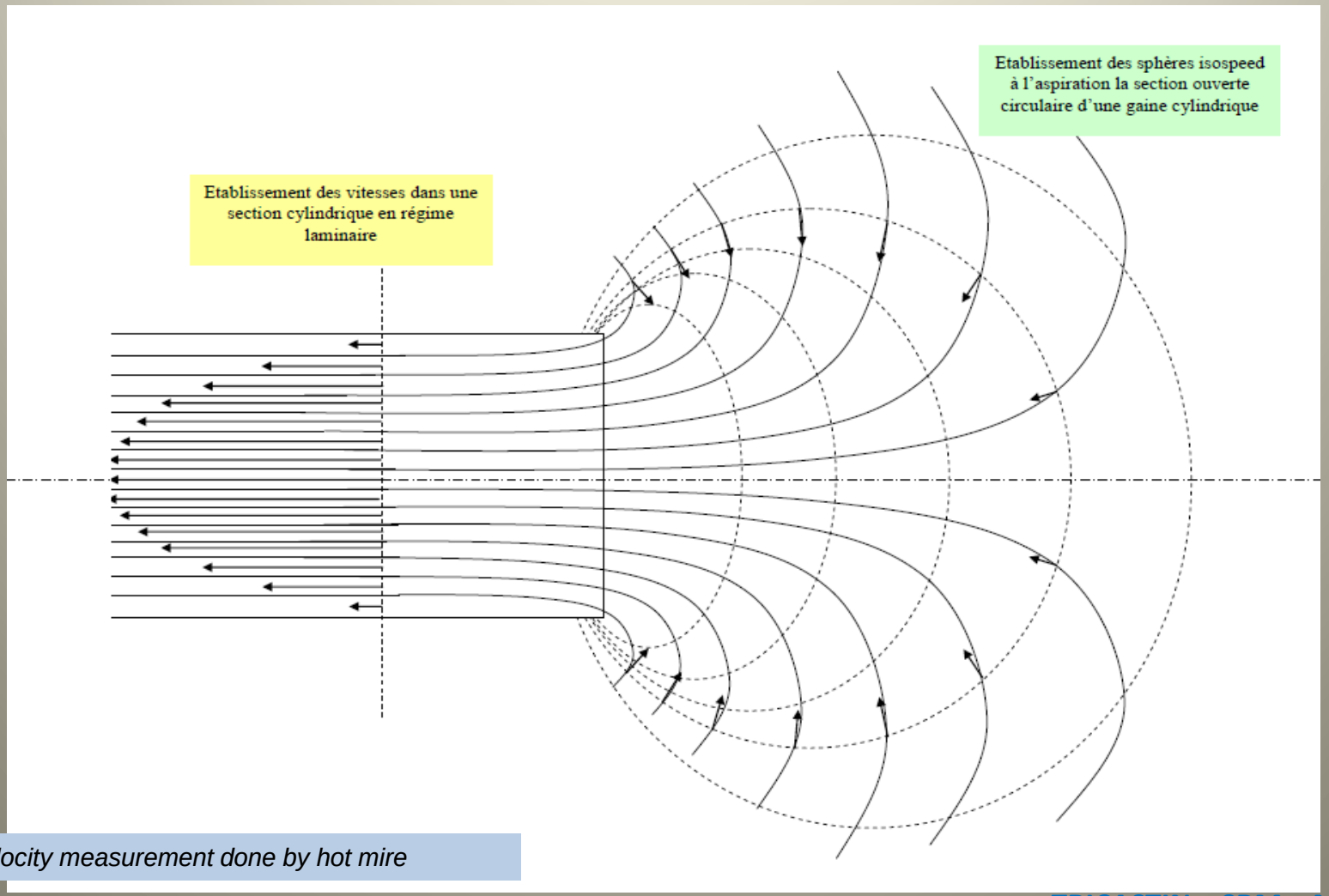
Obstruction of suction inlet is the component of two parameters:

☐The geometry of the suction inlet: plane circular section

☐The speed acceleration phenomenon from the beginning of obstruction and thus the fast raise of velocity up to the total closure.

➔The idea is: To counter the plane section notion and
To avoid the acceleration of the suction air speed.

Analysis of air velocity vectors at suction inlet:

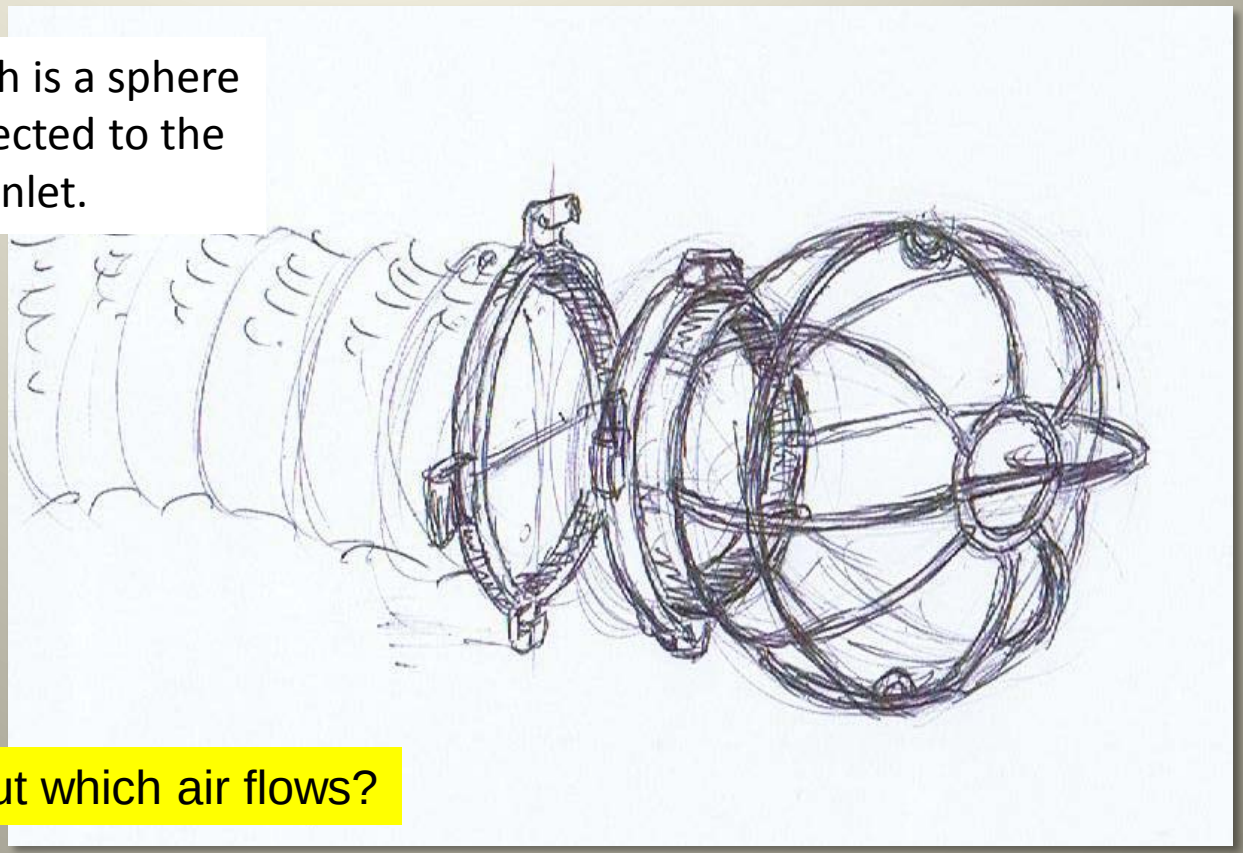


** Air velocity measurement done by hot mire*

In practice: the sphere cage

The idea: ….

➔ The result of this research is a sphere cage which can be connected to the entrance of the suction inlet.

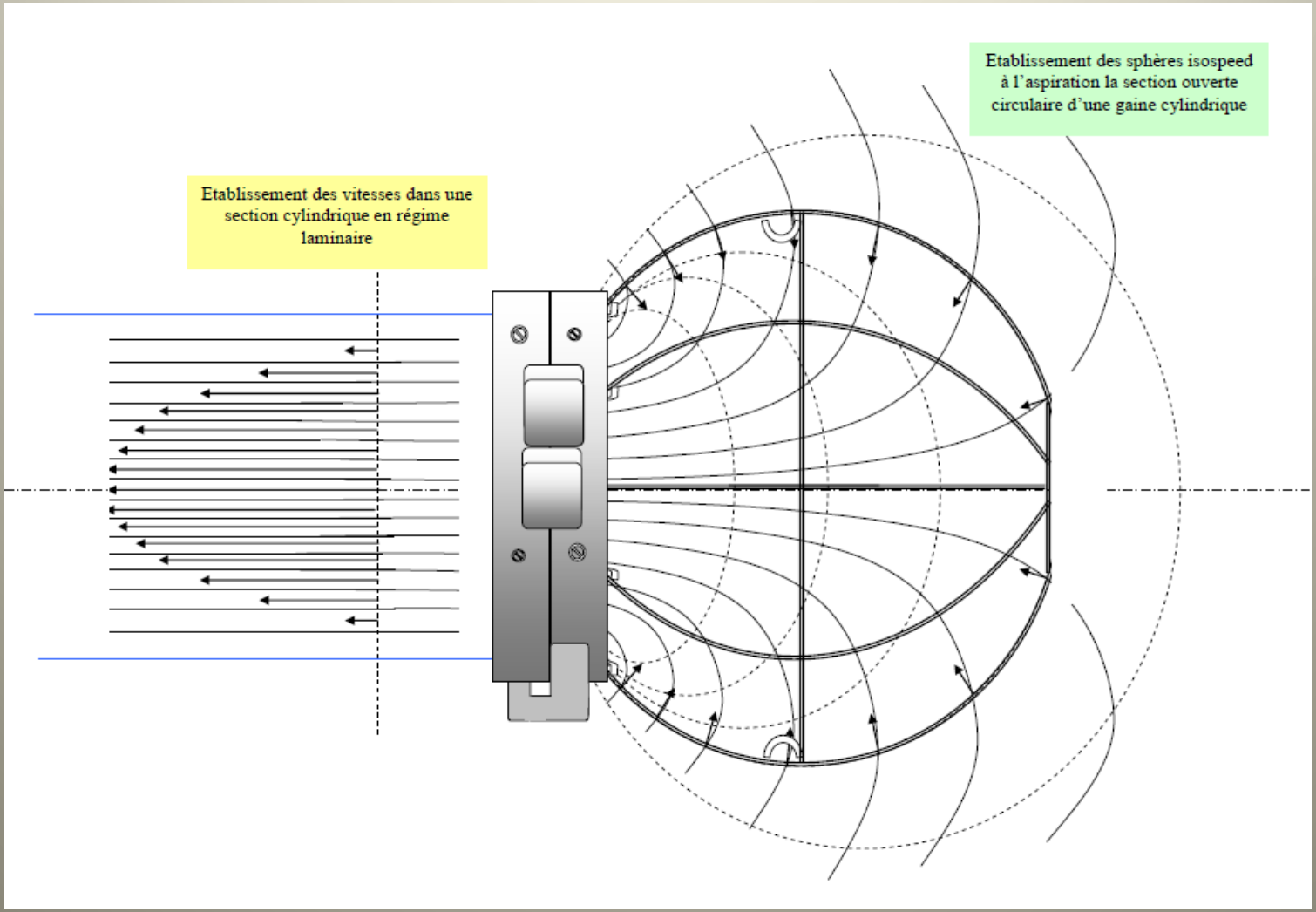


But which dimensions?

But which air flows?

But which speeds?

Application: the principle ...



the Prototype

Sphere cage principle:

- The spherical shape avoids the ease of obstruction.
- At each point of the delimited suction surface, the speed is constant (1.06 m/s is balanced uniformly)
- The surface of the suction section is multiplied by 7.

For a duct section
of Diameter 300 mm

Plane Surface = 0.141 m2
➔ Spherical Surface = 0.785 m2

… to the reality

➔ The airflow into the tent and air renewable rate is always the same and now guaranteed.

➔ The speed acceleration phenomenon is no more possible. There is no risk of obstruction of the suction inlet.

The sphere cage can be adapted to different duct diameters. The ZAG couplings will then be used for DN 300, 200, 170 or 150.

Synthesis: Sphere cages testing and operation during outages have demonstrated the total efficiency and easy implementation in the field, without generating other constraints.

- ***OE - end of outages: sphere cages can be decontaminated in a conventional manner in hot shop for their future use.***

Reminder:

« When an aerosol or iodines monitor alarms ……

…….it's already too late …….. »

Let's work upstream !....

Thank you for your attention.

Thank you to our partner in this adventure