

Optimisation of Sampling for Power Plants

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Optimisation of Sampling Systems for Power Plants

- Derek Lister has much to answer!
- Review of sampling systems - 40+ years

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Detection Levels

- Conventional chemistry
- Radiological (gamma) chemistry

Sample System Design

Sample Characteristics

- Single and multiple phases

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Detection Levels – 1960s/1970s

- Conventional chemistry
 - ppm or mg/l or mg/kg
- Radiological (gamma) chemistry
 - Sodium iodide detectors
 - High efficiency
 - Low resolution
 - » Chemical separations

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Detection Levels – 1990s forward

- Conventional Chemistry
 - ppb or ug/l or ug/kg
 - Desirable levels ppt or ng/kg
- Radiological chemistry
 - Germanium detectors
 - Lower efficiency
 - higher resolution
 - No chemical separations

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Detection levels lowered

- Specifications tightened
 - Sample contamination prevention crucial
 - Trawsfynydd boilers
 - Construction materials more important
 - Ergonomics crucial
 - Comfort
 - Elimination of contamination
 - Bruce B wetness in steam

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Sample Characteristics

- Phases
 - Solids
 - Liquids
 - Gases
 - Mixtures
- Temperature

Designer

- Isolated
- Perfect world
- Operators can be VERY creative!

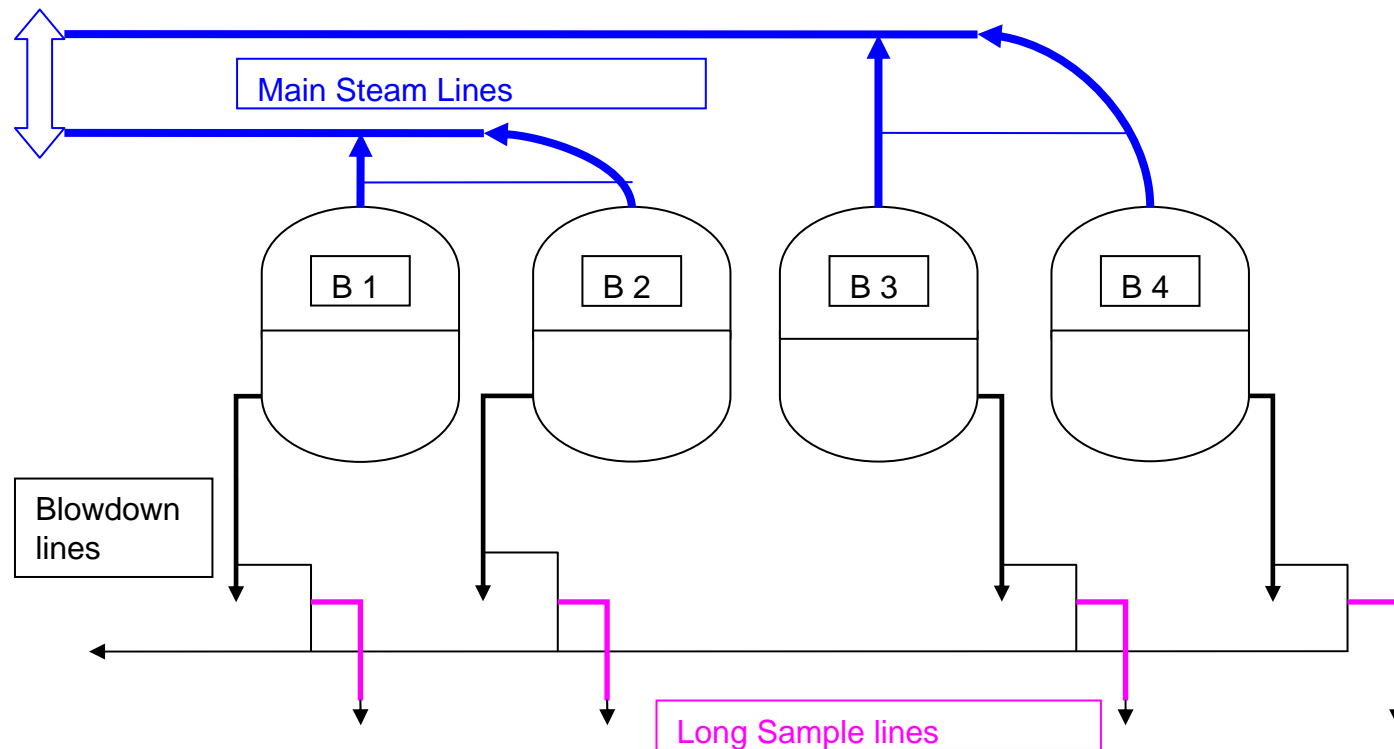
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Sample System Design

- Is the sample representative?
- Bruce B 1987
 - First boiler leak
 - Tried various approaches
 - Tritium
 - Radioiodine
 - Sampling system design!
 - Nitrogen-16 isolated to a boiler pair

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Bruce B 1987 boiler sampling



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Sample System Design

- Is the sample representative?
- Bruce B boiler sampling
 - Interim solution
 - Long term solution

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Sample Characteristics

- Two phase samples - 1970
 - Corrosion product transport (CPT) monitoring
 - Corrosion products soluble and insoluble
 - Capillary sampling at Trawsfynydd
 - No pressure reduction valves!
 - Occasional flow blockage

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Sample Characteristics

- Two phase samples - 1972
 - Oil in reactor coolant
 - Bubble through carbon tetrachloride
 - Contamination issues
 - Sample representativeness
 - On-line gas chromatography
 - Methane, ethane, cyclopropane, neopentane

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Sample Characteristics

- Two phase samples - 1973
 - Cooling ponds analyses
 - alpha emitter concentrations in water
 - Sample flow effects
 - Ergonomics
 - Contamination spread

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Sample Characteristics

- Two phase samples - 1976
- Active Effluent Water Treatment Plant
 - Commissioning new plant
 - Isokinetic sampling system
 - Innovative design
 - Water hammer!

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Sample Characteristics

- Two phase samples - 1986
- CPT monitoring at Bruce B
 - Uncommon practice in Ontario Hydro
 - Flow integrators expensive
 - Design change!
 - Bath chemistry!

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Sample Characteristics

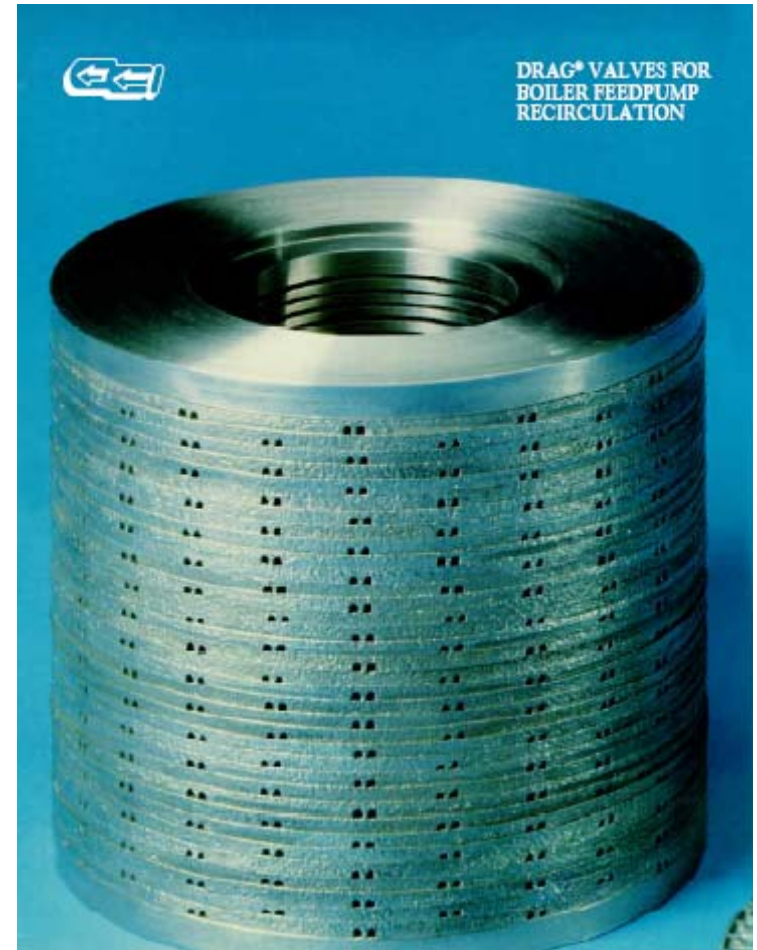
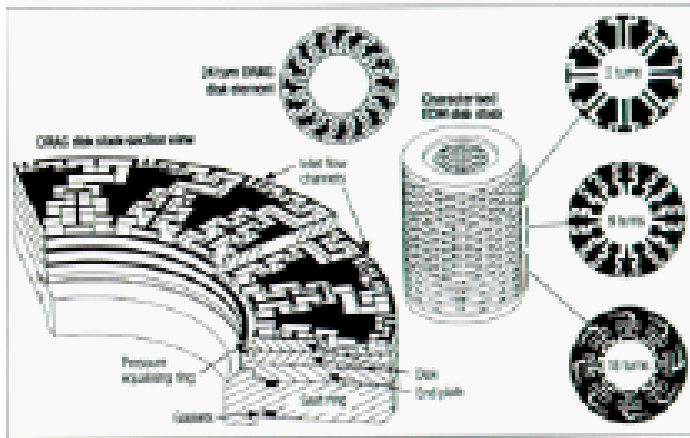
- Long sample lines
 - Issues with “plate out”
 - Solids?
 - Ions?
 - Dissolved oxygen effects?

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Sample Characteristics

- Pressure reduction
- Drag Valve (Control Components Inc)
 - Invariably foul with corrosion product
 - Sample has been altered

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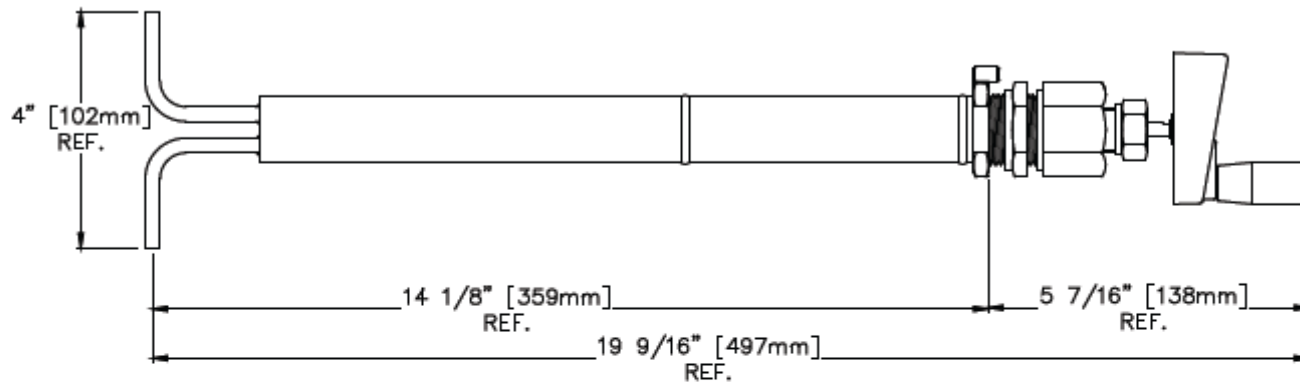
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- Variable pressure Reducing Element
(VREL by Sentry Corporation)
 - Less fouling, more expensive, design change

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Sentry VREL Valve

TECHNICAL DATA



CONSTRUCTION & OPERATION

The VREL[®] consists of two stainless steel tubes joined to a large tube or barrel. A tapered rod assembly is provided and inserted into precision holes in the barrel. The high pressure fluid enters, flows past one rod, turns and flows past the other rod, then out. Pressure drop is a function of the length of the rods inserted into the barrel.

The pressure is reduced smoothly under laminar flow conditions, minimizing dissociation of any components through discontinuous pressure drops. The rod position is controlled externally by turning the knob, and can be adjusted while the sample is flowing. If blockage occurs, the rods can be retracted so that system pressure can blow the solid matter through.

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Sample Characteristics

- Pressure reduction
 - Primary heat transport system samples
 - Pressure reduction coils
 - Flow blockage
 - System contents radioactive
 - Bellows sealed VREL has worked well

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Sample Characteristics

- Two phases plus!
- Moderator water sampling
 - Cleanest system in CANDU
 - Monitor ions and dissolved gases
 - Oil introduced a third phase!
 - Sampling system adequate

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Summary

- Requirements more stringent with time
- Samples must be representative
- Designers must
 - Use operating experience
 - Allow for multiphase samples
 - Assume plant operators will challenge systems