Babcock & Wilcox Canada

a McDermott company

Steam Generator Waterlancing

Introduction

Babcock & Wilcox has developed an efficient, cost-effective inter-tube lancing system that is capable of removing the deposit, or “sludge”, that accumulates on tubesheets and in the tube support openings of recirculating nuclear steam generators. These deposits, which consist of feed train corrosion products and make-up water impurities, promote under-deposit corrosion of steam generator tubing and must be removed to assure tube survivability. Accumulation of deposits in the tube support flow channels leads to a reduction in circulation and ultimately to the onset of two-phase circulation loop instability and unit derating. Removal of these tube support deposits is necessary to return the unit to full power.

The Babcock & Wilcox lancing system has been used extensively to remove the hard tubesheet and tube support sludge found in CANDU steam generators. The modular design of the system allows it to be easily adapted to different steam generator and plant configurations, and automation allows the operator to work in a low dose area away from the steam generator, consistent with ALARA principles.

Waterlance technology

Inter-tube lances are a key component of the Babcock & Wilcox lancing system. A lance (Figure 2) is thin, and flexible enough to travel down the narrow tube lanes. Typically the lances are 0.090” to 0.250” thick and 1” to 2” wide. Babcock & Wilcox has manufactured lances up to 16 feet long.

Tubes in the body of the lance carry high pressure water, at up to 10,000 psi, from a fitting at the rear manifold to the front manifold of the lance. Several distinct waterlance designs are available to deal with different sludge conditions.

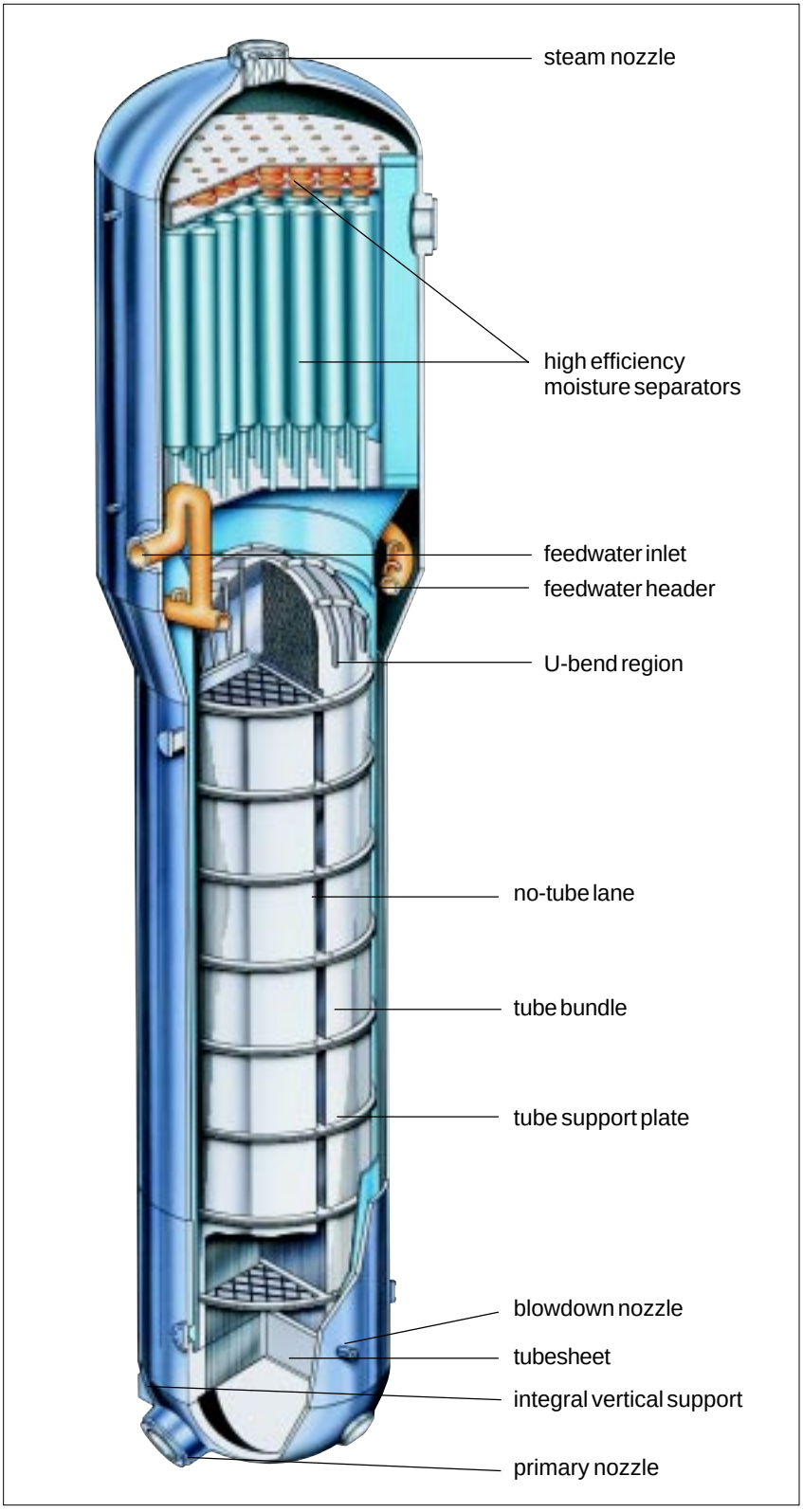

Figure 1: B&W recirculating nuclear steam generator

Steam Generator Waterlancing

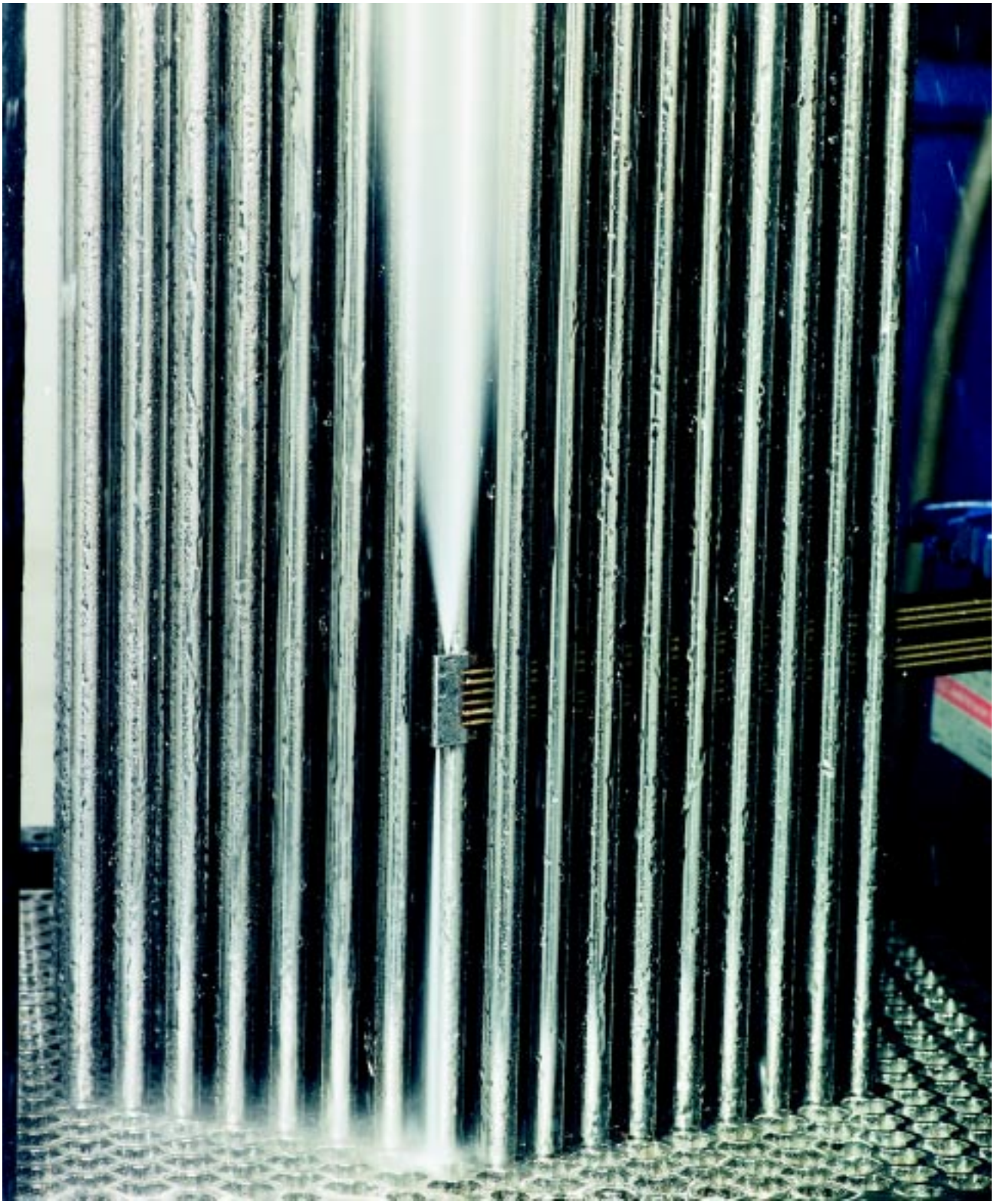

Figure 2: Biased waterlance under pressure in a tube bundle mock-up: balancing jet upward and cutting jet downward

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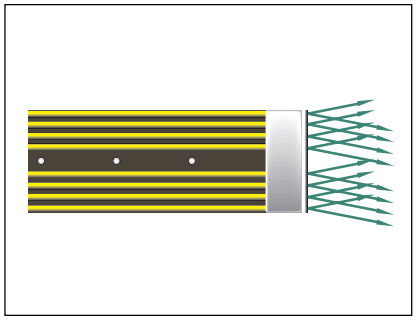

Figure 3a: Tube descaling intertube waterlance

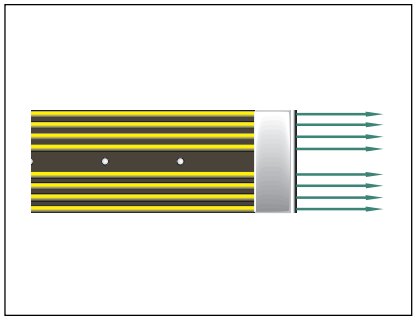

Figure 3b: Straight ahead cutting intertube waterlance

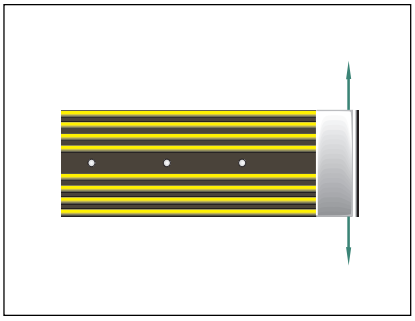

Figure 3c: 90° cutting intertube waterlance

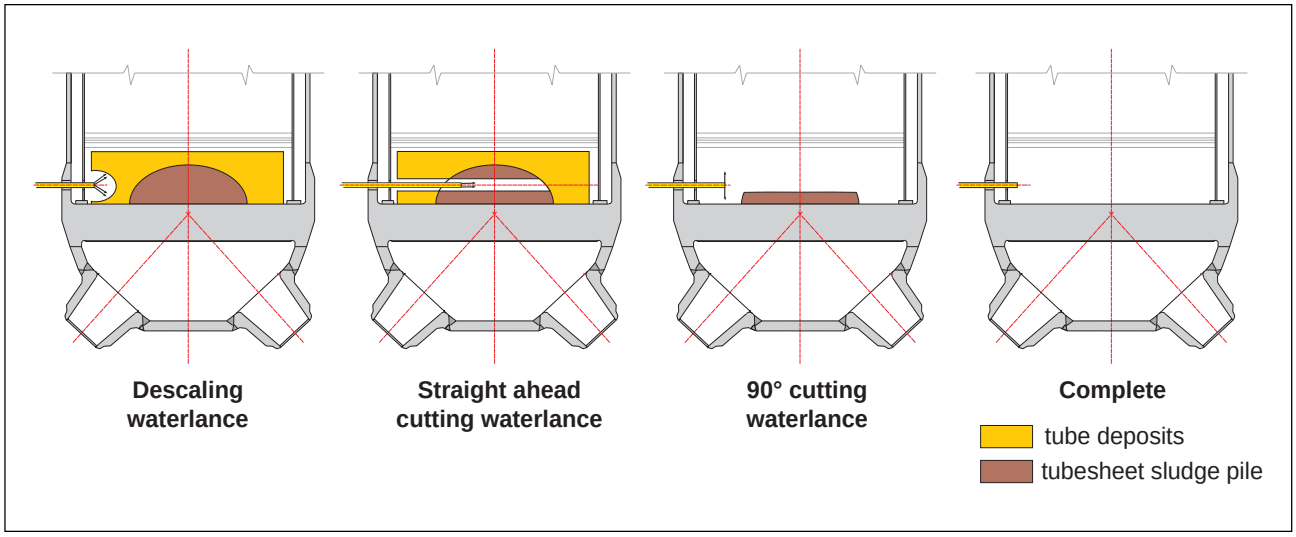

Figure 4: Sequence for waterlancing tube deposits and tubesheet sludge pile

A tube descaling waterlance (Figure 3a) is designed for efficient removal of tube deposits, or scale. 'Descaling' is required in generators where the build up of tube deposits must be removed to allow passage of cutting lances.

The descaling lance utilizes a series of fine waterjets aimed at the tube surfaces. Operated at lower pressure, so as not to damage any tubes, this lance is very effective at removing tube deposits or scale.

The straight ahead cutting lance (Figure 3b) has jets that point forward along the axis of the lance. These jets are effective at removing sludge located in the inter-tube gap. In tall sludge piles, this operation is required to clear a passage for the 90° cutting lance. In most cases this lance is used in combination with a descaling lance.

The 90° cutting lance (Figure 3c) is the "workhorse" as it removes the most sludge and deposits. It has two opposed jets which point up and down, parallel to the steam generator tubing. 90° cutting lances are available biased or unbiased. In the biased variety, one jet is an efficient cutting jet, while the other is designed as an unfocused balancing jet, which has significantly lower cutting power. An unbiased lance uses cutting jets, directed both up and down.

Lance Delivery Systems

Babcock & Wilcox lance delivery systems are able to insert a lance into the tube bundle from either the no-tube lane or from the annulus region of the steam generator.
The systems can be operated remotely, allowing the operator to work in a low dose area, away from the steam generator.

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Waterlancing remote control work stations at Pickering NGS where Babcock & Wilcox deployed 12 waterlance systems in parallel

The no-tube lane waterlancing system accesses the steam generator through a handhole located on the no-tube lane of the steam generator. The lance is supported via a rigid guide in the no-tube lane, and a guide head directs the lance into the tube bundle.

Babcock & Wilcox's annular waterlancing system accesses the tube bundle through a handhole located along the annulus of the steam generator. Similar to the no-tube lane system, the annular system also mounts to a handhole flange. A flexible guide positions the lance in the annulus and a guide head directs the lance into the tube bundle.

In some steam generators, access to many tube lanes can be restricted by tie rods or no-tube lane obstructions. By using both the annular and no-tube lance delivery methods, complete lancing coverage of the steam generator can be ensured.

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Waterlancing experience

Babcock & Wilcox has successfully used intertube high pressure waterlancing to clean sludge and deposit accumulations from:

- U-bend supports
- tube supports
- tubesheets

Our experience includes waterlancing at the following nuclear generating stations:

Canada

Bruce NGS, Ontario
Darlington NGS, Ontario
Gentilly NGS, Quebec
Pickering NGS, Ontario
Pt. Lepreau NGS, New Brunswick

United States

H.B. Robinson NGS, S. Carolina
Palo Verde NGS, Arizona