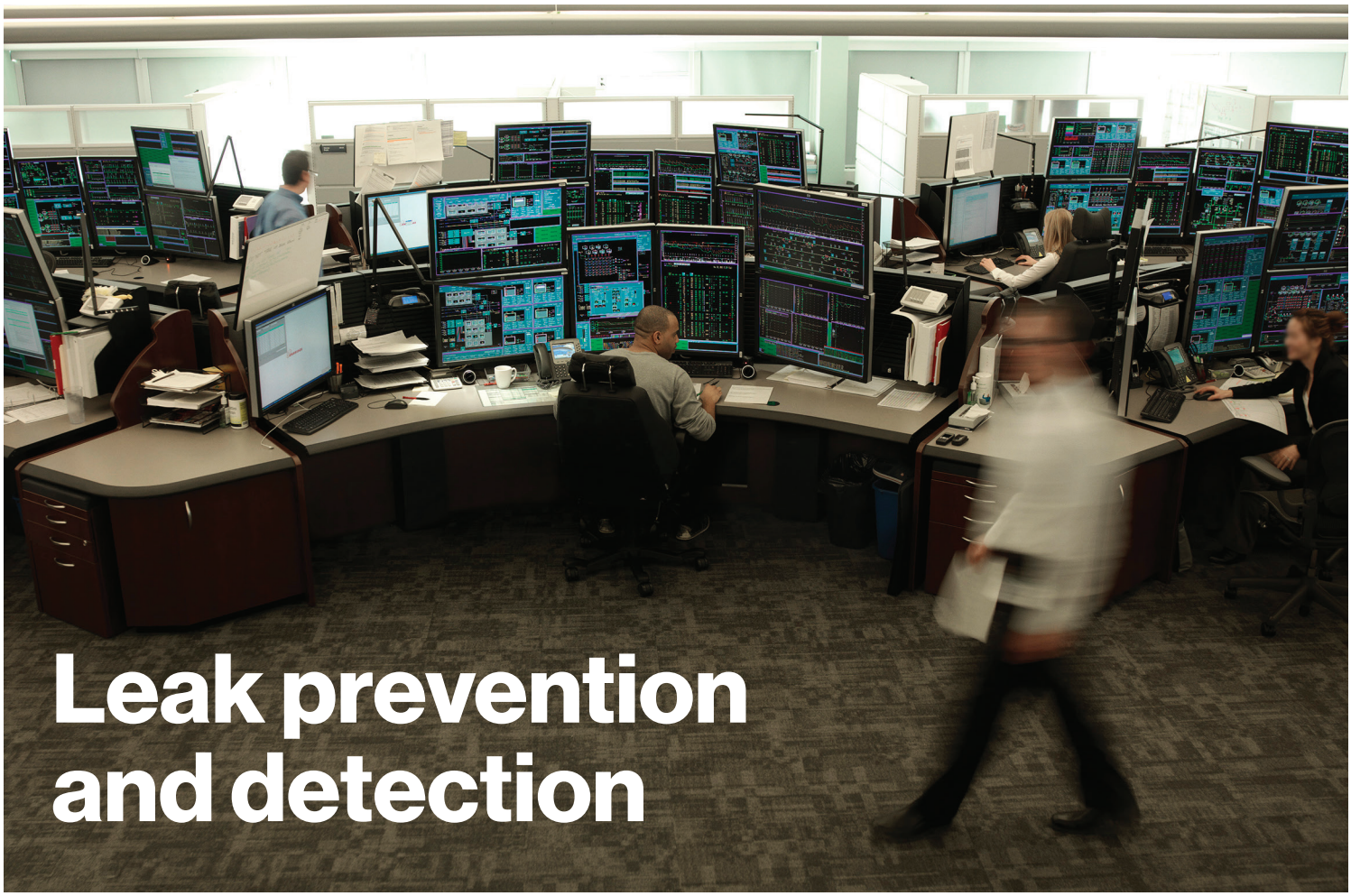

Leak prevention and detection

Prevention and detection are critical components of pipeline safety. Our focus on prevention—with vigorous monitoring, maintenance and inspection programs—keeps our pipelines healthy and fit for purpose. Meanwhile, our leak detection division researches and assesses commercially available technologies to improve safety.

Are pipelines safe?

Pipelines are the safest and most reliable way to move the energy we all use. Still, at Enbridge, we believe all incidents can be prevented.

How much do you invest in safety?

In 2017, we spent $1.95 billion (USD and CAD) on programs that help us maintain the fitness of our systems across the U.S. and Canada.

How do you prevent spills and leaks?

We're active in the area of prevention with in-line inspections, corrosion prevention, and preventative maintenance digs.

How do you carry out leak detection?

With trained operators and multiple, overlapping computerized modelling systems, we monitor our pipeline network 24/7.

How does technology play into this?

We invest heavily in leading-edge tools and technologies to ensure our system is safe.

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Seeking 100-per-cent safety

Over the past decade, we've transported more than 22 billion barrels of crude oil and liquids, with a safe delivery record of more than 99.999 percent. But we know that's not good enough. Our goal—simply, unequivocally—will always be zero incidents.

It all starts with prevention

Preventing incidents before they occur is a critical component of Enbridge's ongoing commitment to safety. This means recognizing conditions that have been known to cause failures in the past—including third-party excavation damage, external corrosion, and cracking or denting—and then working to minimize the risk. It also means adopting the most advanced leak prevention technologies available, following environmentally sound construction practices, and taking a proactive approach to training, inspection, testing, and repair.

These key prevention methods include:

- **In-line inspections**—We regularly schedule inspections using in-line inspection tools, which allow us to monitor the health of our pipeline systems from the inside out. These ultra-high-tech tools use imaging technology, with a level of detail similar to that of MRIs, ultrasound, and X-ray technology in the medical industry, to scan our pipelines on a millimetre-by-millimetre basis.
- **Combating corrosion**—We seek out and prevent any corrosion of the steel in our pipelines using anti-corrosion coatings, cathodic protection (application of a low-level electrical current), and interior cleaning of pipes.
- **Public awareness**—Third-party damage is one of the leading causes of pipeline leaks. We keep in touch with our neighbors, and make sure they know how to stay safe around—and avoid accidentally damaging—our pipelines.
- **Aerial and ground patrols**—We regularly fly all of our 27,350 km (17,000 miles) of liquids pipeline rights-of-way, watching out for potential issues. Our ground-based surveys, including patrols on foot and in vehicles, use GPS and advanced imaging technology to check the depth and position of our pipelines, and detect ground movement.
- **Maintenance digs**—Sometimes, our regular monitoring and inspection program alerts us to pipeline features that may require a preventative maintenance dig (or visual inspection) to determine whether a repair or other action is required.

A commitment to leak detection

We monitor our pipelines for possible leaks using multiple methods, each with a different focus and each using different technology, resources, and timing. Together, these methods provide overlapping and layered leak detection capabilities:

- **Controller monitoring**—Our Supervisory Control and Data Acquisition (SCADA) system is designed to identify operational changes, such as pressure drops, that may indicate a leak. This SCADA system also monitors vapor concentrations, pump-seal failures, equipment vibration levels, and sump levels.
- **Computational pipeline monitoring**—We constantly monitor pressure, temperature and other key data from thousands of points along our systems to quickly identify and respond to unexpected changes. Computer-based systems use measurements and pipeline data to detect anomalies that could indicate possible leaks.
- **Scheduled line balance calculations**—Many times a day, at regularly scheduled intervals, we calculate and confirm that the volumes of crude oil we receive into our pipeline systems precisely matches the volumes we deliver.
- **Visual surveillance**—We conduct regular aerial and ground line patrols on our system, and we operate emergency telephone hotlines for third-party reports.
- **Acoustic emission inline inspections**—Our state-of-the-art monitoring technology also includes sensitive acoustic devices, carried by our in-line inspection tools, that "listen" for leaks.

Harnessing technology

Since 2011, Enbridge's Pipeline Control Systems and Leak Detection (PCSLD) department has harnessed innovation and technology to help us further control and mitigate any potential issue that arises.

In 2017, our research and development (R&D) and innovation-focused groups invested about $15.2 million (USD and CAD) in technology development and innovation projects, largely focused on enhancing pipeline fitness, leak detection and damage prevention.

Some examples of our technology in motion are:

- SmartBall technology, consisting of bowling-ball-sized sensors inside our pipes that detect tiny leaks and mark their location;
- A multi-year project, announced in April 2017, that will see Enbridge and pipeline inspection firm NDT Global develop a nextgeneration inspection tool to advance crack assessment capabilities;
- The ELDER test apparatus, a pipeline leak simulator created to test external leakdetection technologies, such as vaporsensing tubes and fiber-optic cables;
- Our partnership with Hifi Engineering to test and enhance its High Fidelity Dynamic Sensing (HDS) technology; and
- Our ongoing use of satellite data to identify pipeline displacement, down to the millimeter, caused by incremental slope movement over time.

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