

HIGH-FREQUENCY CONSTANT POTENTIAL PIPELINE CRAWLER



High-Frequency Constant Potential Pipeline Crawler – ToronXPC™ 300CP

ToronXPC™-300CP is a high-frequency constant potential pipeline crawler developed specifically for digital radiography (DR) panoramic weld inspection of large-diameter, heavy-wall oil and gas transmission pipelines. Combining a heavy-duty four-wheel-drive crawler chassis with a 300 kV high-frequency constant potential X-ray generator, the system delivers the image clarity, deep wall penetration capability, extended continuous operating time, and high per-charge weld throughput that modern pipeline construction and integrity management programs demand — particularly on high-strength steel grades with a specified minimum tensile strength (SMTS) of 540 MPa and above (API 5L Grade X80 and equivalent).

At the core of the ToronXPC™-300CP is the DIYE-100-CP high-frequency constant potential panoramic X-ray generator, manufactured under OEM partnership with YXLON of Germany. The generator's metal-ceramic tube, 100 kHz operating frequency, and constant potential power supply architecture produce a spectrally harder, more stable X-ray beam than conventional self-rectified or pulsed generators — resulting in lower scatter, superior contrast sensitivity, and more consistent film density across the weld. The 360° × 38° panoramic radiation angle enables full-circumference single-exposure girth weld radiography in a single shot, and the 100% duty cycle at maximum power means the generator can run continuously without forced cool-down intervals that restrict throughput on conventional pipeline crawler X-ray systems.

The crawler drive unit is powered by a high-capacity low-temperature resistant lithium battery pack of at least 4,200 Wh, delivering a pipeline crawling range of 20 km per charge — and capable of inspecting 100 or more girth welds per charge on a Ø 1,422 × 21.4 mm pipeline. Remote kV adjustment from outside the pipeline, a programmable magnetic media command controller with a 100-meter operating radius, and wireless precision positioning compatible with DR pipeline inspection systems combine to make the ToronXPC™-300CP a fully integrated, high-productivity pipeline inspection solution for the most demanding long-distance transmission pipeline projects.

APPLICATIONS

High-Frequency Constant Potential Pipeline Crawler - ToronXPC™ 300CP Applications

- Long-distance large-diameter oil and gas transmission pipeline construction — panoramic DR girth weld inspection on high-strength pipeline steels (API 5L X65, X70, X80, and above)
- High-pressure gas and liquid transmission mainlines — inspection of heavy-wall pipeline joints where deep penetration up to 54 mm steel is required
- Pipeline integrity management and in-service inspection programs — re-inspection of existing girth welds and corrosion assessment on in-service pipeline systems
- Cross-country and long-distance pipeline projects — high-throughput inspection (100+ welds per charge) minimizing battery change downtime on long pipeline strings
- Cold-climate and remote-site pipeline construction — low-temperature battery pack enables operation in Arctic, subarctic, and high-altitude pipeline environments
- Offshore and subsea pipeline construction — panoramic crawler inspection of offshore pipe stalks before installation, where DR digital imaging replaces conventional film
- High-strength steel pipeline projects — specifically suited for pipelines with SMTS ≥ 540 MPa (API 5L X70 / X80 and equivalent) where conventional lower-kV crawlers are insufficient for wall penetration
- Pipeline construction QC for oil sands, LNG, and carbon capture and storage (CCS) pipeline infrastructure

Pipeline Inspection System

Reliable. Precise. Built for Performance.



FEATURES

High-Frequency Constant Potential Pipeline Crawler - ToronXPC™ 300CP

Key Features

- High-Frequency Constant Potential X-Ray Source — 300 kV / 750 W: The DIYE-100-CP generator operates at 100 kHz with a constant potential output of up to 300 kV and 750 W, delivering a spectrally harder, more consistent X-ray beam than conventional pulsed or self-rectified crawlers. The result is superior image contrast, more consistent film density, and reliable penetration of up to 54 mm of steel — the performance needed for heavy-wall, high-strength pipeline girth weld inspection.
- 100% Duty Cycle at Maximum Power: The generator is rated at a 100% duty cycle at maximum voltage and current under a 68 °F (20 °C) ambient — eliminating the forced cool-down intervals between exposures that reduce throughput on conventional crawlers. Back-to-back exposures at maximum power are fully supported, enabling maximum weld inspection rates on high-volume pipeline construction projects.
- Optimized for High-Strength Pipeline Steels (SMTS $\geq$ 540 MPa): The 300 kV tube voltage and 54 mm Fe maximum penetration capability are specifically matched to the wall thickness and material attenuation characteristics of API 5L X70 and X80 grade pipeline steels — the dominant pipe grade on modern long-distance high-pressure gas and liquid transmission pipeline projects.
- Metal-Ceramic Tube with German YXLON Engineering: The X-ray tube is a metal-ceramic construction manufactured under OEM partnership with YXLON, Germany — one of the world's foremost industrial X-ray equipment manufacturers. Metal-ceramic tube technology offers superior thermal stability, longer service life, and more consistent focal spot geometry than conventional glass tube designs.
- Full 360° Panoramic Beam — 38° Vertical Angle: The generator produces a 360° × 38° panoramic radiation cone, irradiating the full pipe circumference in a single exposure with a vertical beam angle matched to pipeline girth weld geometry. Single-shot full-circumference imaging eliminates the multi-shot repositioning sequences required by external or semi-panoramic techniques.
- External kV Adjustment Without Crawler Retrieval: The tube voltage can be adjusted in 1 kV increments from outside the pipeline at any time during the inspection program — without retrieving the crawler. This allows the operator to optimize exposure parameters for variations in pipe wall thickness or material grade within a single pipeline string,

maintaining image quality across the full job without downtime.

- **Magnetic Media Command Controller — 100-Meter Remote Range:** The crawler is controlled via a magnetic media command controller that operates through up to 40 mm of pipe wall at a remote distance of up to 100 meters. Functions include start and stop exposure, and kV increase/decrease — providing full exposure control from the radiation exclusion zone boundary.
- **Wireless Precision Positioning — DR System Compatible:** The integrated wireless precision positioning system is fully compatible with digital radiography (DR) pipeline inspection setups, enabling automated weld centerline positioning and integration with digital imaging workstation software for streamlined inspection workflows.
- **High-Capacity Low-Temperature Lithium Battery — 4,200 Wh+:** The onboard lithium battery pack delivers a minimum capacity of 4,200 Wh and is engineered for low-temperature operation — maintaining full performance in cold-climate pipeline construction environments. The 20 km crawling range and 100+ welds per charge capability on Ø 1,422 mm pipe minimize battery retrieval and recharge time, keeping the inspection program moving continuously.
- **Four-Wheel Drive — 40° Gradient Capability:** The 4WD chassis with a ≥ 400 W drive motor and a 40° maximum climbing angle provides the traction to navigate inclined pipeline sections including hillside crossings, river crossing approach ramps, and above-grade pipeline segments without wheel slip or positioning errors.
- **IP65-Rated Generator Enclosure:** The X-ray generator is housed in an IP65-rated enclosure that is fully protected against dust ingress and directed water jets — essential for reliable operation in the wet, muddy, and dusty conditions of pipeline trench and right-of-way construction environments.
- **Programmable Exposure Delay — 0 to 99 Seconds:** The delayed high-voltage activation is fully programmable from 0 to 99 seconds, providing a configurable safety window for radiation zone clearance before X-ray emission begins — ensuring compliance with radiation safety procedures on any pipeline site.

THEORY & METHOD

Theory and Method

The ToronXPC™-300CP implements internal panoramic radiographic testing (RT) — the established method for girth weld inspection of transmission pipelines. In this technique, the X-ray source is positioned inside the pipe at the weld centerline, and the radiographic detector (film cassette or digital detector array) is wrapped around the outer pipe surface at the weld. A single exposure exposes the entire 360° weld circumference simultaneously, producing a complete radiographic image of the full weld volume in one shot — the most efficient and widely code-compliant method for pipeline girth weld RT.

What distinguishes the ToronXPC™-300CP from conventional pipeline crawlers is the high-frequency constant potential architecture of its X-ray generator. In a conventional self-rectified or single-phase full-wave-rectified X-ray machine, the tube voltage is not constant — it rises and falls with the AC power cycle, producing a pulsating X-ray beam with a broad energy spectrum that includes many low-energy photons. These low-energy photons are preferentially absorbed in the pipe wall, contributing dose to the wall without contributing usefully to the radiographic image, and the voltage ripple causes variation in effective tube voltage that degrades dose rate consistency.

A high-frequency constant potential generator converts the AC power supply through a high-frequency inverter operating at 100 kHz — transforming and rectifying the power at 100,000 cycles per second rather than the 60 or 120 pulses per second of a conventional rectified machine. The resulting DC output has an extremely low voltage ripple (effectively constant potential), producing a harder, more spectrally consistent X-ray beam. The practical benefits are significant: higher effective energy for the same nominal kV setting (greater penetration depth), lower scatter radiation (higher contrast sensitivity), more consistent film density and digital image signal across the weld circumference, and more predictable exposure factors for reproducible results from weld to weld.

The crawler is loaded into the pipeline at the start of each inspection string. Using the magnetic media command controller and wireless remote positioning system, the operator drives the crawler to the target weld location with ± 5 mm positioning accuracy — placing the X-ray focal spot precisely on the weld centerline to satisfy the geometric unsharpness requirements of ASME Section V, API 1104, and ISO 17636. The programmable delayed high-voltage activation (0-99 seconds) allows personnel to clear the radiation exclusion zone before X-ray emission begins, and the exposure time is set in 1-second steps over a range of 1-594 seconds. The kV setting can be fine-adjusted from outside the pipeline in 1 kV steps throughout the inspection program without requiring the crawler to be retrieved — a major productivity advantage on projects with variable wall thickness pipe sections.

TECHNICAL SPECIFICATIONS

High-Frequency Constant Potential Pipeline Crawler - ToronXPC™ 300CP
Technical Specifications

Complete specifications for the ToronXPC™ -300CP crawler drive unit and high-frequency constant potential X-ray generator:

Parameter	Specification
Crawler Drive Unit	
Applicable Pipeline Diameter	600 - 1,600 mm (23.6 - 63 in)
Drive Mode	Four-wheel drive (4WD)
Motor Power	≥ 400 W
Maximum Climbing Angle	40°
Minimum Turning Radius	≤ 6D
Positioning Accuracy	± 5 mm
Crawling Distance per Charge	20 km (12.4 miles)
Weld Joints per Charge (reference)	≥ 100 welds for Ø 1,422 × 21.4 mm pipeline
Battery Pack	
Battery Capacity	≥ 4,200 Wh
Battery Chemistry	Low-temperature resistant lithium battery pack
Magnetic Media Command Controller	

Parameter	Specification
Control Pipe Wall Thickness	40 mm
Remote Control Distance	100 m (328 ft)
Remote Functions	Start exposure, stop exposure, kV increase, kV decrease
External kV Adjustment Step	1 kV per step (adjustable from outside the pipeline)
Exposure Control	
Single Exposure Time Range	1 – 594 seconds (1-second step interval)
Wireless Positioning & Control	Remote wireless precision positioning compatible with DR (digital radiography) pipeline inspection systems
High-Frequency Constant Potential Panoramic X-Ray Generator — DIYE-100-CP	
X-Ray Tube Type	Metal-ceramic tube
Power Supply Mode	High-frequency constant potential
Operating Frequency	100 kHz
Tube Voltage Range	50 – 300 kV
Tube Voltage Adjustment Step	1 kV per step
Tube Current Range	0.5 – 4.0 mA
Tube Current Adjustment Step	0.1 mA per step
Maximum X-Ray Tube Power	750 W
Radiation Angle	360° × 38° (full panoramic)
Focal Spot Size	0.5 × 5.5 mm (per EN 12543)
Maximum Exposure Time Setting	99 minutes 59 seconds

Parameter	Specification
Delayed High-Voltage Activation	0 - 99 seconds (programmable)
Continuous Working Time	≥ 180 minutes at maximum voltage and current
Duty Cycle	100% at maximum power (ambient temperature 68 °F / 20 °C)
Anode Cooling Method	Forced air cooling
Internal Filter	0.4 mm Fe / Ni / Cu
Additional Filter	4 mm Al
Protection Rating	IP65 (dust-tight, protected against water jets)
Input Voltage	200 - 250 VAC; 47 - 400 Hz (110V is also available)
Permissible Operating Temperature	-22 °F to +104 °F (-30 °C to +40 °C)
Weight (X-Ray Generator)	35 kg (77 lb)
Penetration Capacity Reference Conditions	
Maximum Steel Penetration	54 mm Fe
Film-to-Focus Distance (FFD)	700 mm
Film Classification	D7 (ISO 11699-1 Class D7)
Minimum Film Density	≥ 2.0
Reference Exposure Time	10 minutes

* Specifications are subject to change without notice as part of Torontech's continuous product improvement program. Penetration capacity reference conditions: 54 mm Fe at 700 mm FFD using D7 film at density ≥ 2.0 with 10-minute exposure time. Weld-per-charge capability is stated for reference on Ø 1,422 × 21.4 mm pipeline and will vary with pipe diameter, wall thickness, and exposure parameters. Contact your Torontech applications engineer for project-specific configuration guidance.



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