DARLINGTON NUCLEAR GENERATING STATION

BOWMANVILLE, ONTARIO, CANADA

Ontario Power Generation (OPG), working to ensure nuclear power is part of the province's future, is moving forward with a $12.8-billion refurbishment of all four of the nuclear reactors at the Darlington generating station. Located just east of Toronto, Darlington currently utilizes four CANada Deuterium Uranium (CANDU) reactors with a combined net power output of 3,512MW.

The refurbishment program is a massive undertaking that will involve roughly 30 million hours of work and take over a decade to complete. OPG has been preparing for refurbishment since 2009; which would allow continued operation of each refurbished reactor for a period of approximately 30 years. Original operation of the reactors began between 1990 and 1993. The refurbishment project is broken down into two main parts; an in-depth definition phase from 2012 to 2016 and then the execution phase from 2016 to 2023. Ontario Power Generation awarded a joint venture, Aecon Industrial and SNC-Lavalin Nuclear Inc., contracts for both the definition phase ($600 million) and the execution phase ($2.75 billion) of the Re-tube and Feeder Replacement (RFR) project.

Refurbishment requires that the major components in each reactor be inspected and serviced, including required replacements, during a planned outage. Sequentially, the units will be taken out of service, defueled, and drained of their heavy water coolant and moderator before work begins to restore or replace reactor components. The process includes replacement of all the major plant

PROJECT INFORMATION

- Owner: Ontario Power Generation
- Foundation Contractor, Aecon Industrial
- Engineer: SNC – Lavalin Nuclear, Inc.
- Completion Date: 2026
- Project Cost: $12.8 billion
- Maximum Load: 3.88 MN

SERVICES PROVIDED

- Single level O-Cell® load testing
- SONICaliper® profile
- Lateral load testing

components, such as the fuel channels, calandria tubes and feeders, steam generators, turbine generators, fuel handling systems and other ancillary plant equipment.

A key refurbishment activity will be removal and replacement of the fuel channel assemblies and feeder pipes in each of the reactors. A deep foundation was designed for the Re-tube Waste Processing Building (RWPB) that will be constructed to facilitate refurbishment activities. The RWPB is a structural steel warehouse that will be used for processing the refurbishment waste from the 4 units during the next 10 years. Aecon will primarily provide construction and fabrication services for the joint venture, while SNC will focus on specialty tooling and engineering. Complete refurbishment of the four units is scheduled to be done by 2026.

Installing the cage assembly

O-CELL AXIAL LOAD TEST

A "Chicago-Method" O-cell® test was chosen to confirm the design end-bearing assumptions. This variation on the traditional O-cell test places the hydraulic jack at the pile tip with a circular bottom plate of reduced diameter compared to the rock socket. A 1500-mm dedicated test shaft was drilled into overburden and a 1350-mm rock socket was advanced about 2 meters into shale. A SONICaliper™ inspection of the excavation was done for accurate measurement of shape, alignment and verticality, information critical to accurate interpretation of load test results.

The O-cell configuration in the 1500-mm diameter test pile utilized a single 330-mm diameter O-cell located at the shaft base provided a maximum test load of 3.88 MN. The load was to be directly applied to the smaller diameter plate to maximize testing of end bearing using the available side shear capacity above as reaction.

LATERAL LOAD TEST

The lateral load test was performed in accordance to ASTM D3966-07. The 1,500 mm test pile was laterally tested by loading against a 1,500 mm reaction pile. Load was applied with a 2,600 kN hydraulic jack as monitored with a Geokon load cell through a W360X162 strut. The piles were instrumented with strain gages and inclinometers as required. The system applied a maximum load of 1,988 kN between the test and reaction piles for respective deflections of 43 and 37 mm.

CONCLUSIONS

An O-Cell test was performed in order to prove pile design parameters. Load increments were applied using the Quick Load Test Method for Individual Piles (ASTM D1143). The O-cell was loaded in twenty nominally equal increments to a bi-directional gross load of 3.88 MN. The maximum directly applied unit end bearing was 22.36 MPa. The O-cell method proved to be a valuable tool in completing a load testing program where site safety and reducing risk were major considerations. By utilizing the skin friction of the shaft as reaction the O-cell method eliminates the need for a large reaction system at ground level and the test energy is safely buried below ground.

O-Cell and bearing plate assembly with reduced diameter bottom plate

Lateral load test jack and load cell

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