Canadian Nuclear Safety Commission
Commission canadienne de sûreté nucléaire

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Supplementary Information

Presentation from RESD Inc.

In the Matter of the

Ontario Power Generation Inc.

Application for a licence to construct one BWRX-300 reactor at the Darlington New Nuclear Project Site (DNNP)

Commission Public Hearing
Part-2

January 8-10 and 13-14, 2025

Renseignements supplémentaires

Présentation de RESD Inc.

À l'égard d'

Ontario Power Generation Inc.

Demande visant à construire 1 réacteur BWRX-300 sur le site du projet de nouvelle centrale nucléaire de Darlington (PNCND)

Audience publique de la Commission
Partie-2

8-10 et 13-14 janvier 2025

Canada

Independent Review of Flow-Induced Vibrations (FIV) for the BWRX-300 Condenser Tubes

P.J. Sedran, M.Eng, P. Eng.
Mech. Eng. Consultant

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Presentation Contents

1. Introduction – Background
2. Flow-Induced Vibration Assessment
3. Conclusions

1. Introduction – Background

- The following Intervention is in the category of value-added information, based on the intervenors specialised engineering experience.

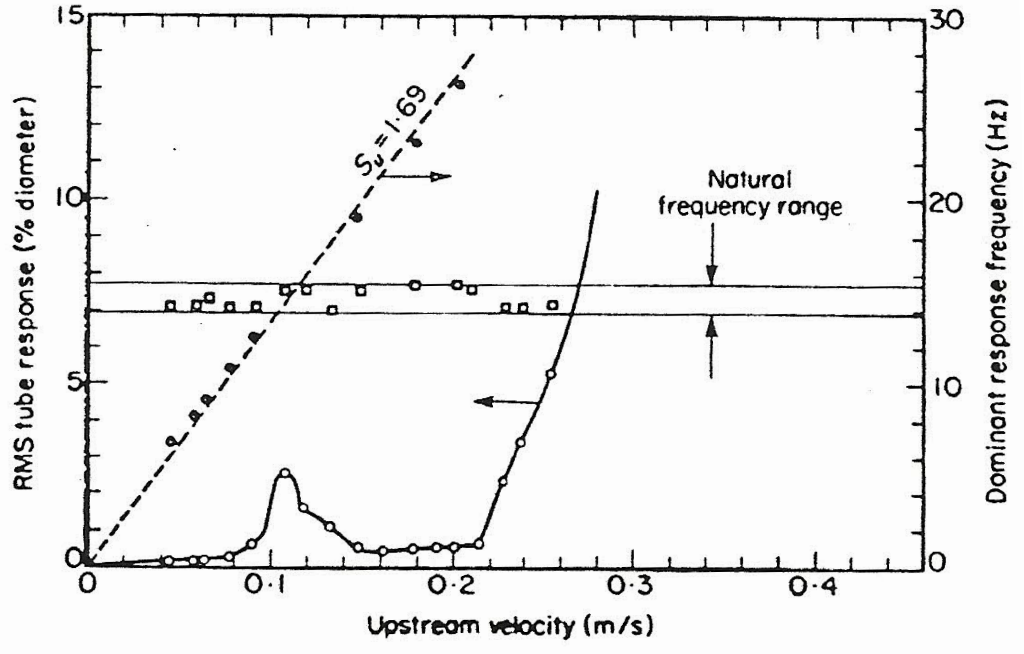
- OPG submissions on the BWRX-300 were reviewed

- A review of Condenser FIV was chosen as an intervention topic, justified by 4 instances of problematic FIV analyses since 2014.

2. FIV Assessment

2.1 Technical Background

Tube Vibration Response vs Flow Velocity



D.S. Weaver, An Introduction to Flow Induced Vibrations, Course Notes, Department of Mechanical Engineering, McMaster University, Hamilton ON, 1988.

Critical Velocity Expression

$$V_c = f_1 D C \left[\frac{m(2\pi\xi)}{\rho D^2} \right]^a$$

V_c is the average pitch velocity of the shell-side fluid at the onset of fluid-elastic instability
f_1 is first natural frequency of lateral vibration of the condenser tube
D is the condenser tube outer diameter
C is an empirical constant
m is the effective mass per length of the tube, including water
ξ is the damping factor (fluid + structural)
ρ is the fluid density
a is an empirical exponent.

2. FIV Assessment

2.1 Preliminary Condenser Design

Table 1 - Inputs Provided by OPG (in a timely and helpful way)

Parameter	Value
Steam Mass Flow Rate into the Condenser	Approximately 250 kg/s
Steam Density at Turbine Exhaust	Approximately 0.03 kg/m^3
Condenser Tube Outer Diameter	27 mm
Condenser Tube Wall Thickness	0.7 mm
Condenser Tube Material	Stainless Steel 316L
Condenser Tube Pattern / Lattice Pitch	Still in development

2. FIV Assessment

2.2 Fluid-Elastic Instability Analysis Results

Estimated Steam Approach Velocity = 61 m/s
Steam Pitch Velocity = 305 m/s

Predicted Critical (Pitch) Velocity = 455 m/s assuming a 36 inch Condenser Tube span length and a baffle width of 13/16 of an inch, with [p / (p-D)] = 5,

where p is the tube lattice pitch

3. Conclusions

1. Design parameter values for the BWRX-300 Condenser Tubes are conventional.

2. The predicted critical velocity of 455 m/s is significantly higher than the estimated pitch velocity of 305 m/s for the first few rows of the Condenser Tubes.

3. Therefore, fluid-elastic instability will not occur in the first few rows of tubes, but the rest of the Condenser Tubes will need to be evaluated in the design phase.