Bruce Power – Ontario, Canada https://youtu.be/fVrIZPhn6vQ

I hope you enjoyed the Bruce Power video.

I thought you might enjoy a bit of history about the Bruce site below.

I was on both the Bruce A and Bruce B design teams. I was not happy with the decision in the late 1990's to mothball Bruce A rather than refurbish it. Thankfully management decided not to decommission the plant. At the time the management had lost faith in the design, construction and operating organizations to execute a major refurbishment program on budget and on schedule. Ontario Power (later OPG) had just come through a difficult project on Darlington (significantly over budget and schedule) and there was no appetite to do another large nuclear project.

That situation changed after the Bruce site was leased to Bruce Power, a private company, originally owned by British Energy and later sold to a number of private companies and pension fund. Bruce Power made the case for refurbishing and restarting 2 units at Bruce A with the private sector taking on some of the risk. It was accepted by the government who wanted to see the private sector succeed in the nuclear sector. The poor performance of the Pickering A refurbishment project from 1998 to 2002 by Ontario Power was likely also a motivating factor for the government to give a private company an opportunity to see what they could do.

I'm glad Bruce Power got the job done. They did have some problems and there were some schedule and cost over-runs but they were manageable thank goodness.

The fellow with the British accent from time 3:29 to 3:35 on the video was Bob Nixon, Vice President-Operations. Bob and I worked closely on the commissioning tests for the Bruce B boiler level control system 20 years earlier in the mid 1980's. He was a Technical Supervisor-I&C in Operations at the site and I was the Supervising Design Engineer-Process Control and Analysis in the Engineering Office in Toronto at the time.

A lot of my American nuclear friends don't believe a CANDU reactor as a power maneuvering rate of up to 1% full power per second from the 25% full power to 80% full power range because CANDU's don't have a large thick walled pressure vessel for the reactor that slow things down. When I did technical papers for USA conferences the peer reviewers kept changing the rate to 1% full power per minute. Each time I had to send the reviewers a copy of the actual station power transient charts before they would approve the technical paper for publication. The very fast maneuvering rate combined with a very unique feed-water system

with external preheaters for the boilers resulted in the most complex boiler control system in the world. My design team spent a few years on extensive computer modelling and simulation to ensure the boiler level control would perform under normal, plant upset and single control system failures. There were a number of advanced control features and fault tolerant logic built into the plant's digital control computer algorithms to satisfy the plant performance requirements. CANDU plants used digital computer control since the early 1970's.

A few years after commissioning Bruce B we ran a weekend deep load maneuvering test from 100% full power to 25% back up to 100%. Both the safety analysis and the control system simulation analysis indicated the plant could do it safely. The test was performed to demonstrate the analysis was correct so the company could license the plant for daily shallow maneuvers down to 65% and deep load maneuvers down to 25% on the weekends. The company was preparing for the start up of Darlington's 3,600 MW of capacity that would create periods of excess nuclear production during low electrical demand periods. Both Bruce B and Darlington had been designed for daily shallow maneuvers down to 65% but commissioning tests at Bruce B indicated we had large safety margins so we used them to demonstrate Bruce B could do deep weekend load maneuvers. The extra time over the weekend allowed us to manage the Xenon transients by carefully programming the power maneuvers to be slower so as to reduce the Xenon buildup and not poison the reactor.

The tests were successful and demonstrated that the safety margins in the safety analysis were real. The operators were fine with the shallow maneuvers down to 65% overnight but when we entered the deep maneuvers the plant process transients on many of the plant systems were larger than the operators were comfortable with. Not all the plant systems had sophisticated digital computer controls. Only the major control loops for the reactor, boilers and turbine-generators did. Management decided to accept the operator's recommendations to eliminate the licensing request for deep load maneuvers. Bruce A and B eventually got licensed for shallow maneuvers down to 65% full power.

It was fun being part of developing the Bruce Nuclear Power site which was the largest nuclear energy centre in the world at the time Bruce B started up. The site is 2 miles by 2 miles. When Bruce B started up the site had 8 operating (two groups of 4 with a common 4-unit control room) and 1 decommissioned reactor (Douglas Point). When USA nuclear plant visitors came up to see the site we would take them to the public observation building at the top of the escarpment and they were always impressed by the size of the site. The site also had 2 large heavy water plants operating at that time (since decommissioned) and the largest zero-emission district heating system in the world (about 1,000 MWt) powered by the 4 Bruce A nuclear units. The district heating system was sized for 4 heavy

water plants. The last two were never built due to declining electricity demand in the 1980's/1990's and the resulting scaled-down nuclear build program - Darlington was the last nuclear new build in Ontario and started up in the early to mid 1990's.

Pickering and Bruce CANDU units traded places in the record books for continuous power production by a nuclear plant for many years. However, eventually a Pickering reactor held that record for 22 years at 894 days. A few years ago the record moved to the UK and then to India. Last Feb 2021 a Darlington CANDU unit set a new world record for both nuclear plants (and thermal plants I believe) at 1106 days of continuous power production. All of the record holders have on-power refuelling designs (CANDU, PHWR and AGR reactors).

I retired in 2002 before the refurbished Pickering A or Bruce A units came back on-line.

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