

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
OFFICE OF NEW REACTORS
WASHINGTON, DC 20555

June 15, 2017

NRC INFORMATION NOTICE 2017-03: ANCHOR/DARLING DOUBLE DISC GATE VALVE
WEDGE PIN AND STEM-DISC SEPARATION
FAILURES

ADDRESSEES

All holders of an operating license or construction permit for a nuclear power reactor under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," except those that have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.

All holders of and applicants for a combined license under 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to inform addressees of operating experience regarding Anchor/Darling (a subsidiary of Flowserve) double disc gate valve (DDGV) failures. This IN provides a discussion of the recent LaSalle County Station Unit 2 Anchor/Darling DDGV failure, events at Browns Ferry that led to Part 21 reporting, and other operating experience that resulted in stem-disc separations. This document contains information available to NRC staff as of May 2017. The NRC expects recipients of this IN to review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this IN are not NRC requirements; therefore, no specific action or written response is required.

DESCRIPTION OF CIRCUMSTANCES

LaSalle County Station, Unit 2

On February 11, 2017, during a refueling outage at LaSalle County Station, Unit 2, the licensee was attempting to fill and vent the high-pressure core spray (HPCS) system when the Unit 2 HPCS injection isolation valve (an Anchor/Darling 12-inch DDGV) would not open on demand. Initial analysis identified that a stem-disc separation occurred as a result of excessive wear of the valve stem threads and shear failure of the wedge pin. The licensee has not completed their root cause determination. The licensee reported this event in Licensee Event Report (LER) 2017-003-00, dated April 12, 2017 (Agencywide Documents Access and Management System (ADAMS) Accession No. [ML17102B424](#)).

The licensee had been using industry guidance to perform visual evaluations and diagnostic testing on the valve. The guidance was based on earlier operating experience from an event on October 20, 2012, at Browns Ferry Nuclear Plant, Unit 1. This event resulted in two reports

ML17153A053

under 10 CFR Part 21, "Reporting of Defects and Noncompliance." The first Part 21 report was issued by the Tennessee Valley Authority (TVA), "Anti-Rotation Pin Failure in Anchor Darling (Flowserve) Double Disc Gate Valve," dated January 4, 2013 (ADAMS Accession No. [ML13008A321](#)) and the second by Flowserve, "Wedge Pin Failure in Anchor/Darling Double-Disc Gate Valve at Browns Ferry Nuclear Plant Unit 1," dated February 25, 2013 (ADAMS Accession No. [ML13064A012](#)).

Browns Ferry Nuclear Plant, Units 1 and 2

On October 20, 2012, a Browns Ferry Nuclear Plant, Unit 1, high-pressure coolant injection (HPCI) steam isolation valve, which also serves as a containment inboard isolation valve, failed its local leak rate test. Investigation revealed that, although the event was not a stem-disc separation, the wedge pin failed and one of the two disc retainers (see Figure 1) fell from the stem-to-upper wedge connection into a space between the valve discs, causing one of the two discs not to properly seat. The valve was a 10-inch Anchor/Darling DDGV. It was installed in 2007 and had not been disassembled since installation. The licensee, TVA, submitted a 10 CFR Part 21 report, dated January 4, 2013 (ADAMS Accession No. [ML13008A321](#)), for this failure. In the report, TVA determined that the wedge pin failed because the vendor had not properly torqued the stem-to-upper wedge connection during manufacture.

Before the 2012 failure, Browns Ferry Nuclear Plant experienced two other wedge pin failures in 10-inch Anchor/Darling DDGVs. The first wedge pin failure involved a Unit 2 HPCI outboard steam isolation valve installed in 2001 that failed during testing that same year. The vendor determined that the stem-to-upper wedge connection was not properly torqued. The second wedge pin failure occurred in 2008 and involved a Unit 1 HPCI outboard steam isolation valve installed in 2006 that failed during local leak rate testing. Internal inspection of the valve revealed that the stem-to-upper wedge connection was not properly torqued.

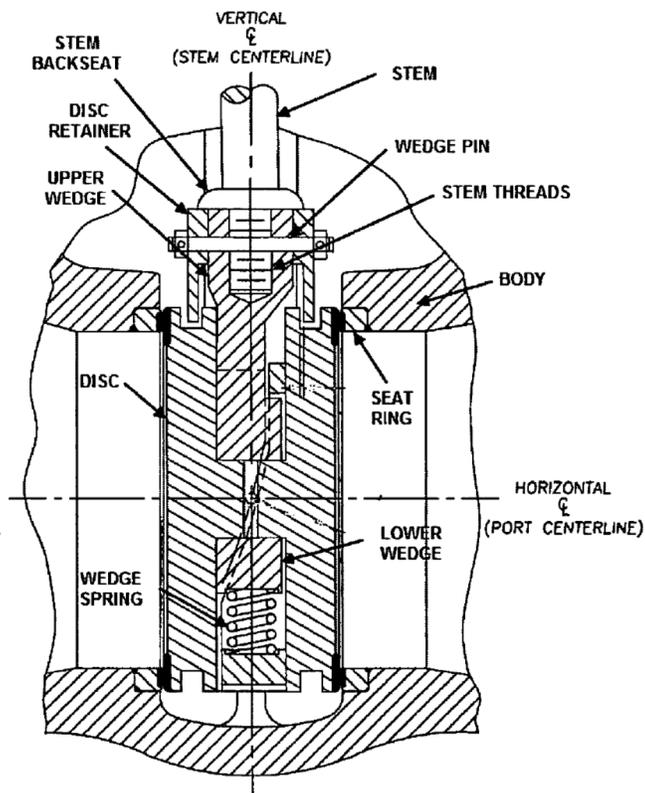


Figure 1 Typical Anchor/Darling DDGV (ADAMS Accession No. ML13064A012)

Surry Power Station, Unit 2

On February 2, 2011, Surry Power Station, Unit 2, tripped as a result of a low-flow condition in the reactor coolant system (RCS) "C" loop. The low-flow condition was the result of a stem-disc separation of the RCS "C" loop isolation valve. The valve was an Anchor/Darling 30-inch DDGV. Inspection of the valve internals revealed that the wedge pin failed and the upper wedge threads exhibited excessive wear. The root cause was determined to be flow-induced vibration coupled with inadequate torque of the stem-to-upper wedge connection, documented in LER 2011-001-00, dated April 1, 2011 (ADAMS Accession No. [ML11105A032](#)). A similar stem-disc separation occurred in 1999 on the RCS "A" loop isolation valve (also an Anchor/Darling 30-inch DDGV). In the 1999 event, the wedge pin failed, allowing the stem to unthread from the upper wedge connection (see LER 1999-003-00, dated July 30, 1999 (ADAMS Legacy No. [ML9908120152](#))).

River Bend Station, Unit 1

On May 21, 2007, an unexplained drop in the reactor recirculation system loop "A" flow occurred at River Bend Station, Unit 1. Reactor power lowered to approximately 96.5-percent power with no operator action. Operators determined that the most probable cause for the condition was that the loop "A" discharge isolation valve caused partial flow blockage. The valve was a 20-inch Anchor/Darling DDGV. Further investigation during the plant shutdown revealed a stem-disc separation and severely worn stem and upper wedge threads. The wedge pin failed, with the two portions extending into the upper wedge still in place while the piece that transverses the shaft was missing. The licensee identified several contributing causes for the valve failure, including inadequate torque of the stem-to-upper wedge connection during the

previous valve assembly, and flow-induced vibration at the disc assembly caused by turbulent flow through the valve coupled with partial extension of the disc assembly into the flow stream.

DISCUSSION

Wedge pin failures and stem-disc separation events associated with Anchor/Darling DDGVs have occurred at both pressurized-water reactor and boiling-water reactor plants. As previously mentioned, the 2012 event at Browns Ferry Nuclear Plant, Unit 1 resulted in the issuance of 10 CFR Part 21 reports by both TVA (ADAMS Accession No. [ML13008A321](#)) and Flowserve (ADAMS Accession No. [ML13064A012](#)).

In its Part 21 report, Flowserve concluded that at Browns Ferry Nuclear Plant, Unit 1:

...failure was due to the shearing of the wedge pin which serves a joint locking function at the threaded interface between the valve stem and upper wedge. The pin is designed to ensure that the joint does not loosen due to vibration and other secondary loads. On some valve designs, the pin also is used to attach the disc retainers to the upper wedge. The pin shearing allowed rotation of the stem during the closing stroke when the valve was seating and ultimately resulted in loss of the stem to upper wedge joint integrity.

Flowserve has completed an evaluation of the failure and concluded the root cause of the wedge pin failure was excessive load on the pin. The stem operating torque exceeded the torque to tighten the stem into the upper wedge before installation of the wedge pin. The additional stem torque produced a load on the wedge pin creating a stress which exceeded the pin shear strength causing the failure. The recommended assembly stem torque did not envelope the operating torque for the TVA application providing the potential for an over load situation and ultimate failure. The operating torque for the TVA valve was unusually high due to the fast closing time of the actuator and very conservative closing thrust margin.

This situation can potentially occur on any Anchor/Darling type double-disc gate valve with a threaded stem to upper wedge connection, typically size 2.5" and larger, operated by an actuator that applies torque on the stem to produce the required valve operating thrust. An operating stem torque greater than the assembly stem torque can provide the opportunity for excessive pin load and potentially failure.

The stems on most double-disc (DD) gate valves larger than size 2" are attached to the upper wedge using UN [unified constant pitch] threads. A pin is installed through the hub of the upper wedge and stem threaded section to prevent the stem from loosening and eventually unscrewing from the wedge. In addition, the disc retainers on some DD gate valves are attached using the wedge pin. See Figure 1. The output torque of the actuator is transmitted to the stem/wedge joint through the stem and is resisted by the disc wedge pack, therefore the stem to wedge connection is loaded by the stem torque and thrust. The wedge pin is not designed to withstand the full actuator output torque. The actuator torque direction tends to tighten the stem into the wedge during closing and tends to loosen the stem during opening.

Flowserve's Part 21 also states:

Flowserve recommends that all critical Anchor/Darling Double-Disc Gate valves with threaded stem to upper wedge connections and actuators that produce a torque on the stem be evaluated for potential wedge pin failure.

This IN provides a discussion of the recent LaSalle County Station, Unit 2 Anchor/Darling DDGV failure, events at Browns Ferry that led to Part 21 reporting, and other operating experience that resulted in stem-disc separations. This document contains information available to NRC staff as of May 2017. The licensee for LaSalle County Station, Unit 2 is in the process of completing their root cause determination. Licensees can use this information in addition to the technical information provided in the 2013 Flowserve Part 21 report to consider actions, as appropriate, to avoid similar problems.

CONTACT

This IN requires no specific action or written response. Please direct any questions about this matter to the technical contacts listed below.

/ra/

Louise Lund, Director
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

/ra/

Timothy J. McGinty, Director
Division of Construction Inspection
and Operational Programs
Office of New Reactors

Technical Contacts: John W. Thompson, NRR/DIRS
301-415-1011
E-mail: John.Thompson@nrc.gov

Michael Farnan, NRR/DE
301-415-1486
E-mail: Michael.Farnan@nrc.gov

Note: NRC generic communications may be found on the NRC public Web site, <http://www.nrc.gov>, under "NRC Library," "Document Collections."

NRC INFORMATION NOTICE 2017-03, "ANCHOR/DARLING DOUBLE DISC GATE VALVE WEDGE PIN AND STEM-DISC SEPARATION FAILURES," DATE: June xx, 2017

ADAMS Accession No.: ML17153A053; *concurred via email

TAC No. MF9698

OFFICE	NRR/DPR/PGCB/LA	TECH EDITOR	NRR/DIRS/IOEB/TL	NRR/DIRS/IOEB/TL	NRR/DIRS/IOEB/BC
NAME	ELee	JDougherty*	JThompson*	EThomas*	HChernoff*
DATE	06/02/17	06/05/17	06/12/17	06/12/17	06/12/17
OFFICE	NRR/DPR/PGCB/LA	RI/DRS/DD	RII/DRS/DD	RII/DRP/D	RIII/DRS/D
NAME	ELee	JYerokun*	MMiller*	JMunday*	KO'Brien*
DATE	06/12/17	06/13/17	06/13/17	06/13/17	06/07/17
OFFICE	RIV/DRP/D	RIV/DRS/DD	NRR/DSS/D	NRR/DRA/DD	NRR/DE/DD
NAME	TPruett*	JClark*	MGavrilas*	SWeerakkody* (A)	KCoyne* (A)
DATE	06/12/17	06/12/17	06/12/17	6/13/17	06/13/17
OFFICE	NRR/DLR/D	NRR/DIRS/D	NRR/DPR/PGCB/PM	NRR/DPR/PGCB/BC	NRO/DCIP/D
NAME	GWilson*	CMiller*	NMartinez	AGarmoe (A)	TMcGinty
DATE	06/13/17	06/13/17	06/14/17	06/14/17	06/14/17
OFFICE	NRR/DPR/D				
NAME	LLund				
DATE	06/15/17				

OFFICIAL RECORD COPY