National Transportation Safety Board
Office of Research and Engineering
Washington, DC 20594

DCA24MM031

SAFETY RESEARCH GROUP (RE-10)

Specialist's Data Report
March 4, 2025

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A ACCIDENT

Location: Baltimore, Maryland
Date: March 26, 2024
Time: 1:27 a.m. Eastern Daylight Time
6:27 a.m. Coordinated Universal Time
Vessel: DALI

B SAFETY RESEARCH GROUP (RE-10)

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NTSB
Washington, DC

C SUMMARY

On March 26, 2024, about 1:27 a.m. Eastern Daylight Time, the 984-foot-long Singapore-flagged cargo vessel (containership) *Dali* was transiting out of Baltimore Harbor in Baltimore, Maryland, when it experienced a loss of electrical power and propulsion and struck the southern pier supporting the central truss spans of the Francis Scott Key Bridge. A portion of the bridge subsequently collapsed into the river, and portions of the deck and the truss spans collapsed onto the vessel's forward deck.

D DATA REQUEST

The NTSB Office of Marine Safety (OMS) asked the NTSB Safety Research Division to examine marine events involving loss of power or loss of propulsion/steering as well as those involving vessel contacts with bridges. Specifically, the OMS requested analyses about the following types of events that occurred within the ports and waterways of the United States:

- those that involved vessel loss of electrical power as the initiating event,
- those that involved loss/reduction of vessel propulsion/steering as the initiating event, and
- those that involved vessel contacts with bridges.

OMS requested analyses describing the incidence of such events for all vessels and for large-class vessels. Additionally, for events involving vessel contacts with bridges, OMS requested the following more detailed analyses:

- vessel dimensions (gross tonnage, length, breadth, and depth) of large-class vessels that contact bridges, and
- the proportion of bridge contacts involving large-class vessels that were associated with various issues, including but not limited to vessel loss of electrical power or loss/reduction of vessel propulsion/steering.

E DATA SOURCE

Marine Information for Safety and Law Enforcement

The US Coast Guard's Marine Information for Safety and Law Enforcement system (MISLE) is used to store data on investigations into marine casualties as well as information about pollution incidents, search-and-rescue cases, law enforcement activities, and vessel inspections.[1] In June 2024, the Coast Guard Office of Investigations and Casualty Analysis provided the NTSB with datasets extracted from MISLE. The data included Incident Investigation Activities (IIA) involving reportable marine casualties (as defined in Title 46 *Code of Federal Regulations* Part 4) with a start date between January 1, 2002, and January 1, 2024. The set was limited to IIAs with an activity status of "closed." Consequently, open incidents, such as the *Dali* contact with the Francis Scott Key Bridge were not included. The dataset included tables that provided details on persons, vessels, and facilities involved in the IIAs as well as a timeline table that provided information about the event sequences of the IIAs.

F METHODOLOGY

The MISLE "MCR-TimelineEvents" table was used to identify IIAs that involved a "loss of electrical power," a "loss/reduction of vessel propulsion/steering," or an "allision," which is the term used in MISLE to refer to the striking of a moving vessel against a stationary object.[2]

The "MCR" table was used to identify which event was designated as the "initiating event" as well as to document other details related to the IIA, such as its date and whether injuries or property damage resulted.

The "MCR-InvFacilities" table was used to identify IIAs that involved bridges. The resulting sets were cross-referenced to identify IIAs that involved both bridges and allisions (BAs).[3]

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[1] See the Coast Guard's "MISLE/ PDA Guidance" web page for more information.
[2] MCR refers to Marine Casualty Reports.
[3] (a) This data query had the potential to include a small number of IIAs that involved both bridges and

The "MCR-InvVessels" table was used to identify vessel characteristics. This included the use of the "VslClass" field to identify a select group of vessels likely to include large ocean-going vessels. This group—bulk carriers, general dry cargo ships, passenger ships, refrigerated cargo ships, ro-ro cargo ships, tank ships, and warships—is referred to in this report as "large-class vessels."

Initial MISLE queries of the vessel dimensions (length, breadth, depth, and gross tonnage) of large-class vessels involved in BAs found that those fields were completed in less than 20% of cases. Consequently, staff reviewed the narrative fields in MISLE to determine the specific vessel(s) in each BA event that contacted a bridge and then used the Coast Guard's Port State Information Exchange (PSIX) search tool, which is also derived from MISLE, to individually search for dimension data using the vessel identification number. For some foreign-flagged vessels that were not available in PSIX, the Electronic Quality Shipping Information System (Equasis) search tool was used.[4]

Because MISLE does not include coded fields describing causes or findings of IIAs, the narratives from the BAs involving large-class vessels were reviewed qualitatively for the detail-level analyses. NTSB investigators reviewed the narratives to identify issues related to the BAs. Issues were classified into categories related to operations, vessels, bridges, and the environment.

G RESULTS

The dataset included 94,218 closed IIAs involving reportable marine casualties with a start date between January 1, 2002, and January 1, 2024.

IIAs Involving Loss of Electrical Power

There were 4,132 IIAs that involved a loss of electrical power, representing 4.4% of all IIAs in the dataset. Of IIAs that involved a loss of electrical power, 1.1% (n=45) involved fatalities or injuries, and 28.0% (n=1,158) involved property damage.

In 58.2% (n=2,405) of cases that involved a loss of electrical power, it was listed as the initiating event. Within that set of cases, there were 2,901 involved vessels. The vessel count exceeds the IIA count because some IIAs involved multiple vessels. Figure 1 depicts the count of involved vessels by vessel class. Towing vessels and

allisions but did not involve vessels alliding with bridges (for example, a vessel alliding with another object under a bridge). However, this query was used because it was the approach most likely to capture all IIAs that involved vessels alliding with bridges. (b) For the remainder of this report, the term BA will refer to an IIA that involved both a bridge and an allision.

[4] Equasis was developed by the European Commission and the French Maritime Administration to "promote the exchange of unbiased information and transparency in maritime transport." See the "About Equasis" web page for more information.

passenger ships were the most common vessel classes involved in IIAs with a loss of electrical power as the initiating event.

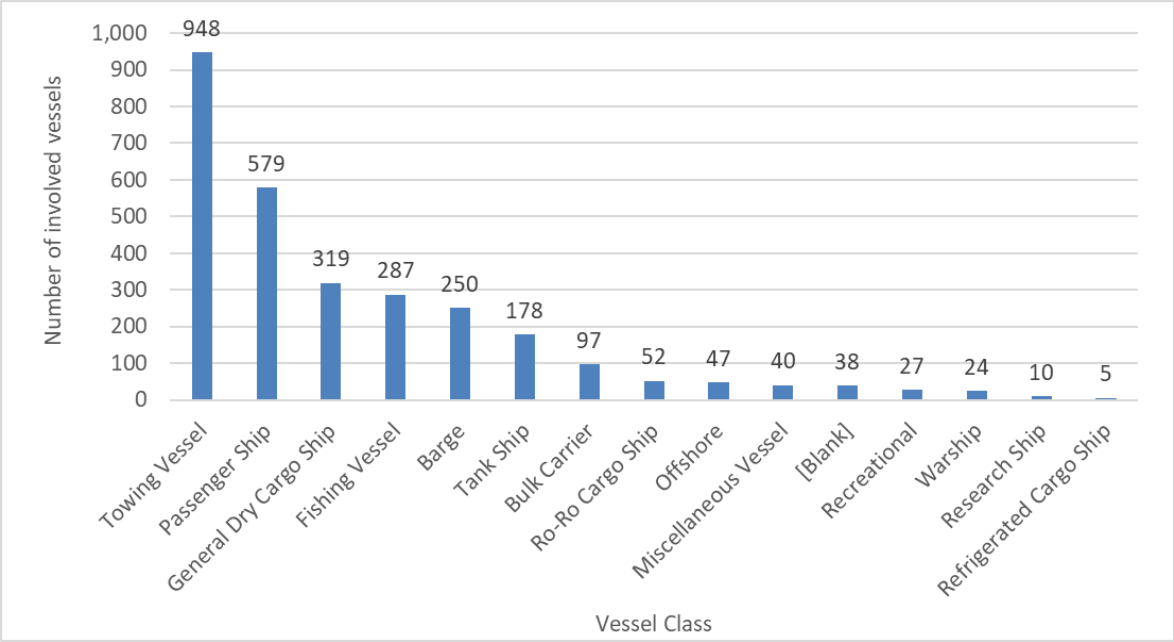

Figure 1. The number of vessels, by vessel class, involved in IIAs in which loss of electrical power was the initiating event for the period from 2002 to 2023.

Table 1 and figure 2 show the number of IIAs between 2002 and 2023 by whether the IIA involved a large-class vessel. Overall, 51.1% of IIAs in which loss of electrical power was the initiating event involved a large-class vessel. For both all vessels and large-class vessels, there was a peak in IIAs involving loss of electrical power in 2011 followed by a reduction in the decade that followed.

Table 1. The number of IIAs in which loss of electrical power was the initiating event by year, between 2002 and 2023, that involved or did not involve a large-class vessel.

Calendar Year	Involved Large-Class Vessel	Did Not Involve Large-Class Vessel	Total
2002	43	70	113
2003	51	43	94
2004	58	43	101
2005	46	39	85
2006	52	53	105
2007	62	50	112
2008	81	57	138
2009	81	60	141
2010	81	94	175
2011	99	105	204
2012	83	77	160
2013	65	76	141
2014	68	76	144
2015	58	47	105
2016	45	34	79
2017	40	37	77
2018	37	32	69
2019	48	43	91
2020	30	38	68
2021	31	41	72
2022	39	35	74
2023	30	27	57
Total	**1,228**	**1,177**	**2,405**

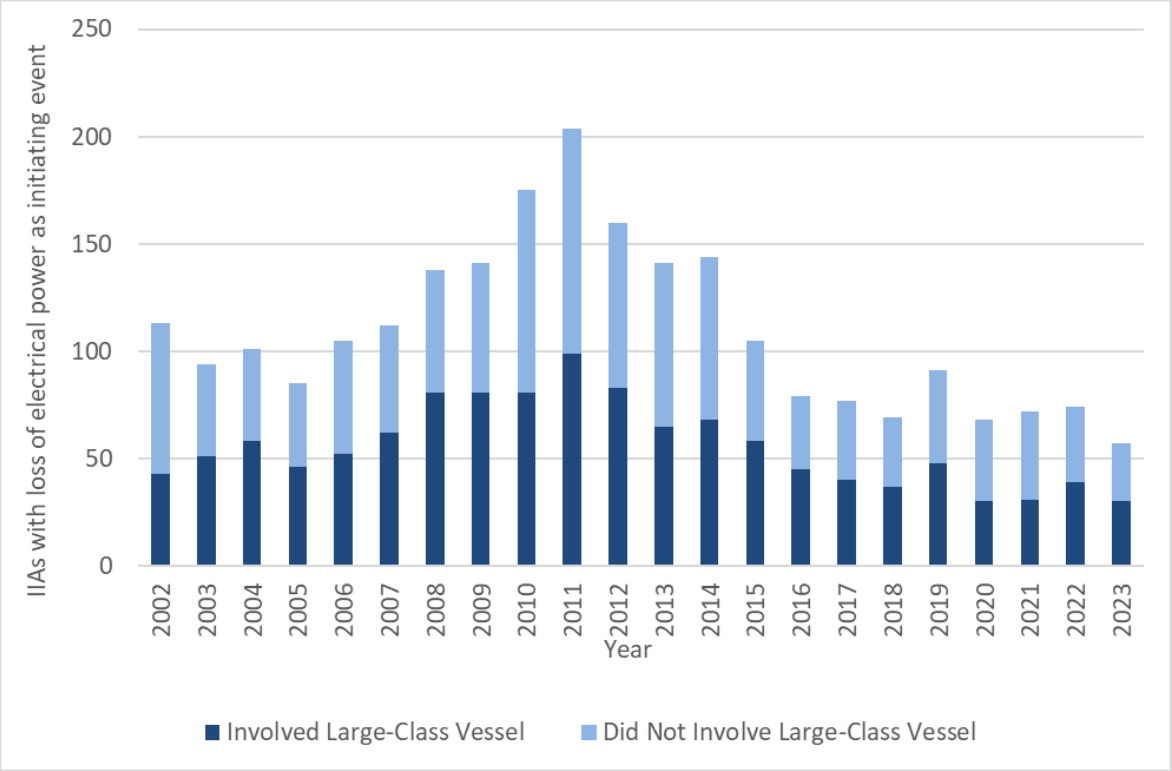

Figure 2. The number of IIAs in which loss of electrical power was the initiating event by year, between 2002 and 2023, that involved or did not involve a large-class vessel.

IIAs Involving Loss/Reduction of Vessel Propulsion/Steering

There were 31,594 IIAs that involved a loss/reduction of vessel propulsion/steering, representing 33.5% of all IIAs in the dataset. Of IIAs that involved a loss/reduction of vessel propulsion/steering, 1.2% (n=367) involved fatalities or injuries, and 33.3% (n=10,508) involved property damage.

In 35.4% (n=11,196) of cases that involved a loss/reduction of vessel propulsion/steering, it was listed as the initiating event. Within that set of cases, there were 14,758 involved vessels. Figure 3 depicts the count of involved vessels by vessel class. The most common involved vessel types were towing vessels and passenger ships.

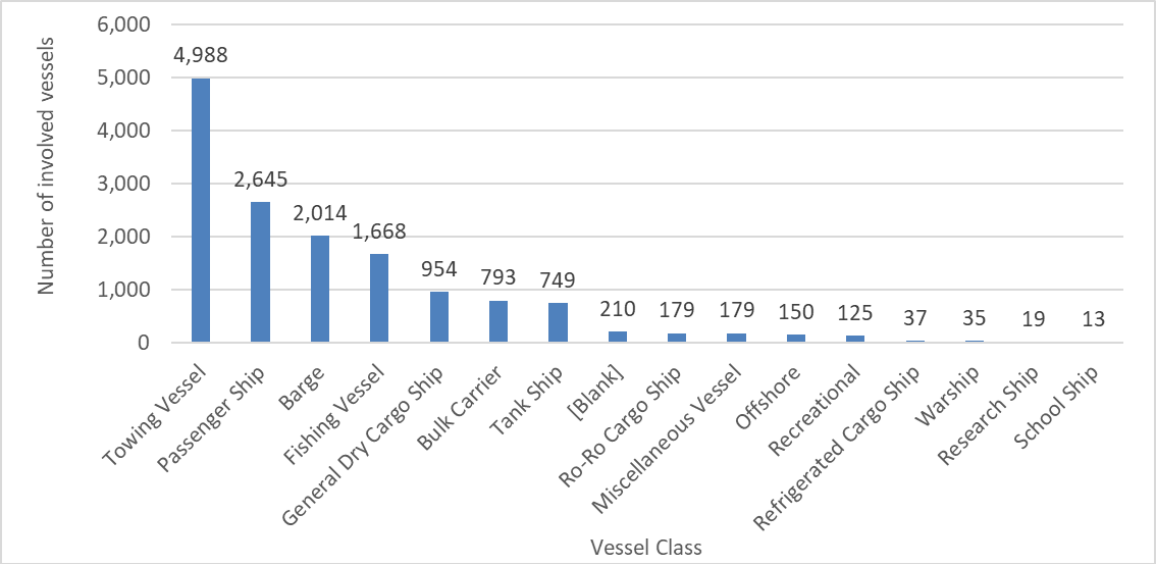

Figure 3. The number of vessels, by vessel class, involved in IIAs in which loss/reduction of vessel propulsion/steering was the initiating event for the period from 2002 to 2023.

Table 2 and figure 4 show the number of IIAs between 2002 and 2023 that involved a loss/reduction of vessel propulsion/steering as the initiating event by whether the IIA involved a large-class vessel. Overall, 46.9% of those IIAs involved a large-class vessel. For both all vessels and large-class vessels, the number of IIAs involving a loss/reduction of vessel propulsion/steering as the initiating event fluctuated over that period.

Table 2. The number of IIAs in which loss/reduction of vessel propulsion/steering was the initiating event by year, between 2002 and 2023, that involved or did not involve a large-class vessel.

Calendar Year	Involved Large-Class Vessel	Did Not Involve Large-Class Vessel	Total
2002	301	269	570
2003	251	242	493
2004	193	190	383
2005	177	143	320
2006	162	209	371
2007	211	222	433
2008	179	296	475
2009	256	322	578
2010	302	354	656
2011	314	352	666
2012	289	316	605
2013	265	349	614
2014	299	319	618
2015	271	226	497
2016	205	198	403
2017	213	225	438
2018	226	327	553
2019	275	289	564
2020	186	288	474
2021	250	284	534
2022	217	262	479
2023	206	266	472
Total	**5,248**	**5,948**	**11,196**

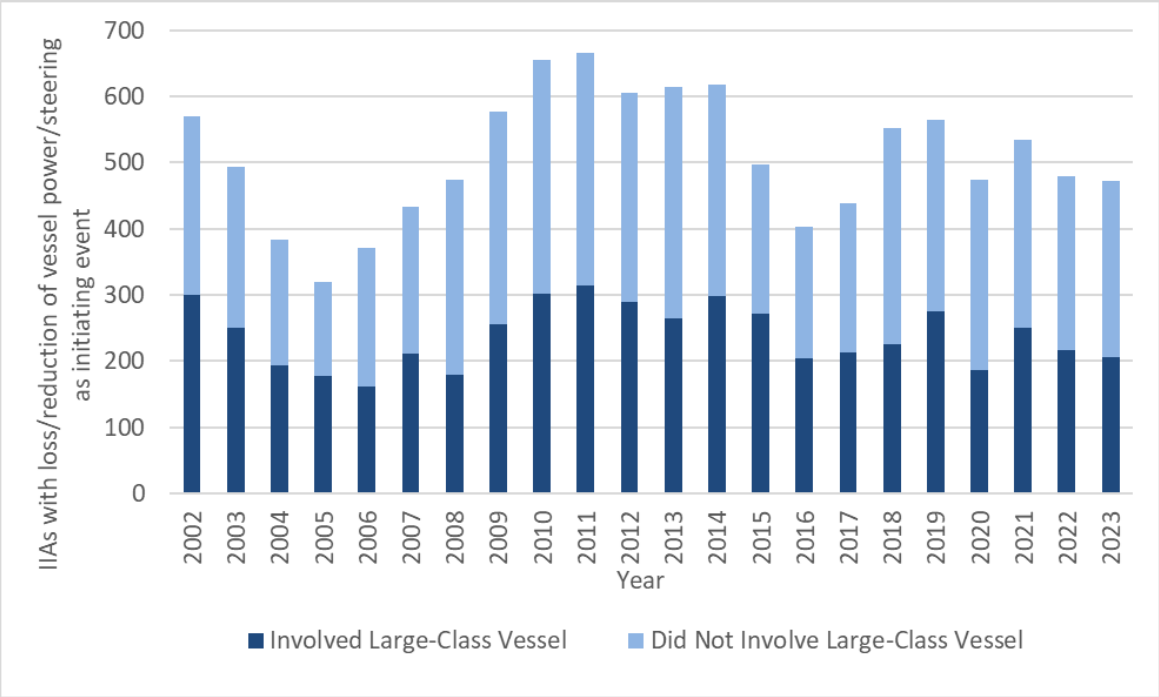

Figure 4. The number of IIAs in which loss/reduction of vessel propulsion/steering was the initiating event by year, between 2002 and 2023, that involved or did not involve a large-class vessel.

BAs

There were 3,953 IIAs involving bridges, including bridges that may not be trafficked by ocean-going vessels, and 12,332 IIAs involving allisions. When these datasets were cross-referenced, there were 3,838 BAs (that is, IIAs that involved bridges and allisions), representing 4.1% of all IIAs.

Within that set, 0.9% of BAs (n=35) involved fatalities or injuries, and 51.0% (n=1,958) involved property damage. The most common types of property damage occurred to vessels (n=1,394), followed by facilities (n=541), other (n=269), and cargo (n=71).

There were 9,177 vessels identified as being involved in BAs. Figure 5 depicts the count of involved vessels by vessel class. The most common involved vessel types were barges and towing vessels.

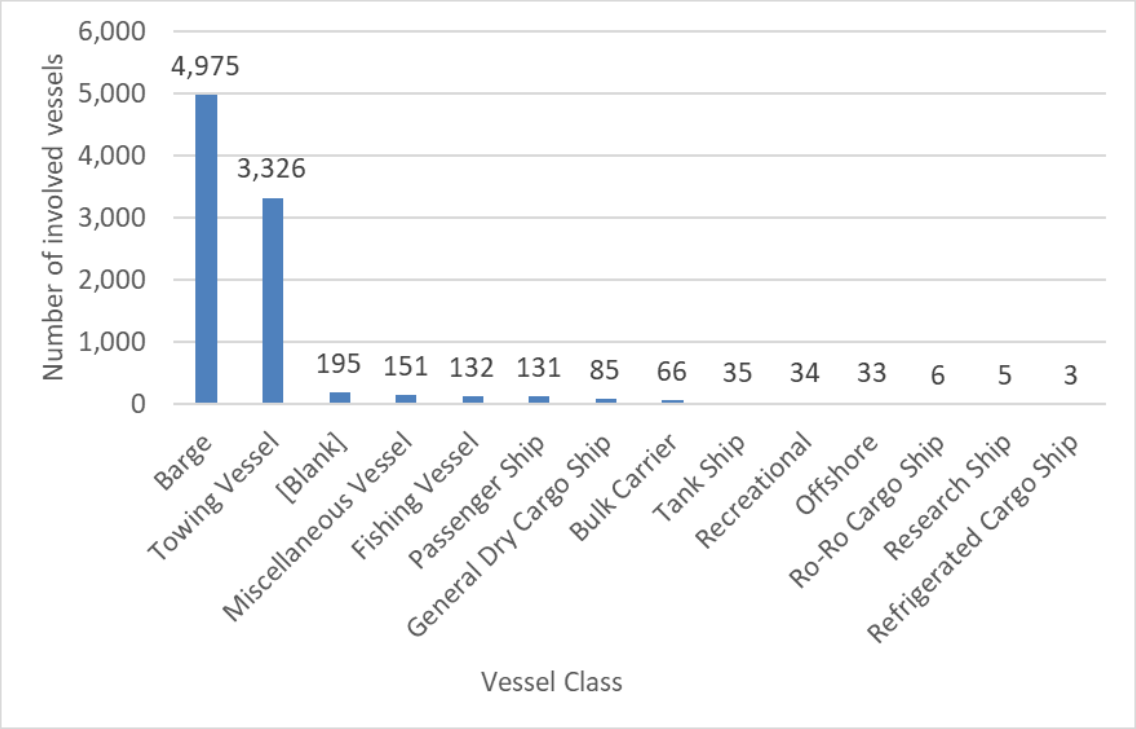

Figure 5. The number of vessels, by vessel class, involved in BAs for the period from 2002 to 2023.

Table 3 and figure 6 show the number of BAs between 2002 and 2023 by whether the BA involved a large-class vessel. Overall, 337 (8.8%) of BAs involved large-class vessels. The number of BAs per year over the time period studied fluctuated for both BAs involving all vessels and large-class vessels.

Table 3. The number of BAs by year, between 2002 and 2023, that involved or did not involve a large-class vessel.

Calendar Year	Involved Large-Class Vessel	Did Not Involve Large-Class Vessel	Total
2002	4	69	73
2003	12	114	126
2004	10	233	243
2005	35	175	210
2006	21	211	232
2007	18	275	293
2008	24	198	222
2009	16	196	212
2010	20	217	237
2011	12	168	180
2012	12	105	117
2013	16	149	165
2014	20	143	163
2015	9	155	164
2016	18	144	162
2017	16	109	125
2018	14	137	151
2019	14	160	174
2020	11	148	159
2021	14	149	163
2022	12	151	163
2023	9	95	104
Total	**337**	**3,501**	**3,838**

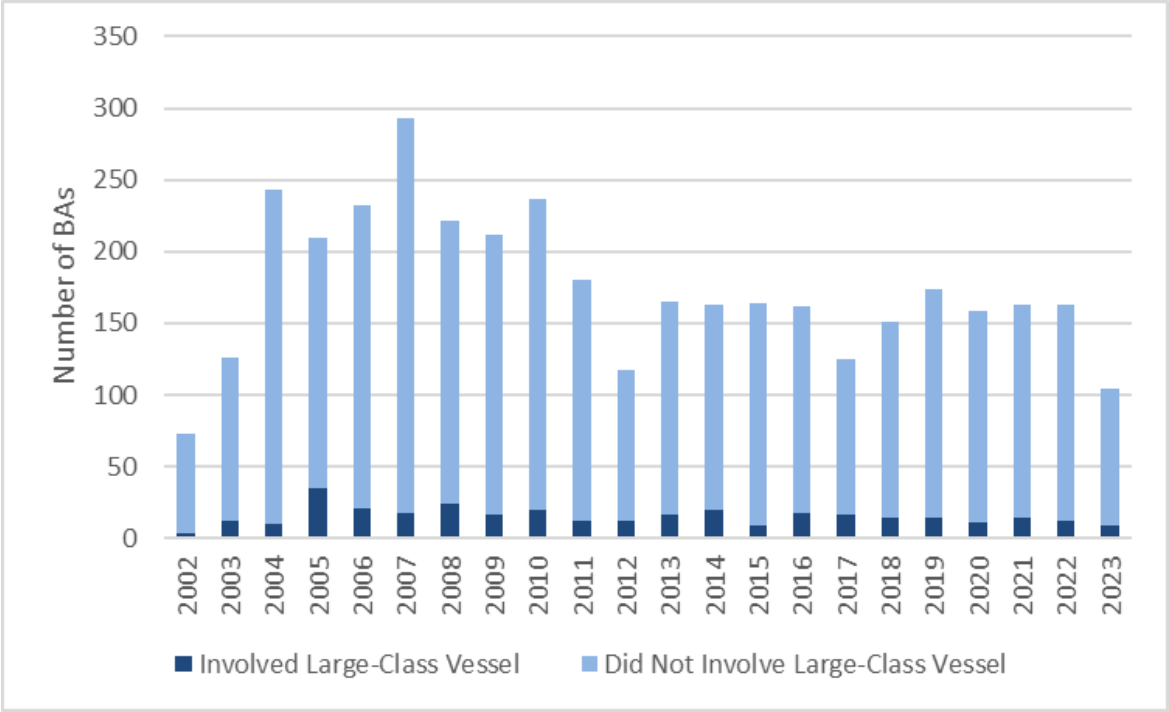

Figure 6. The number of BAs by year, between 2002 and 2023, that involved or did not involve a large-class vessel.

Dimensions of Vessels that Contacted Bridges in Large-Class Vessel BAs

There were 337 BAs that involved large-class vessels. An initial review of narratives resulted in removing 9 additional cases from consideration because they involved allisions with dams or locks rather than bridges or were duplicates with other cases. There were 694 vessels associated with the remaining 328 BAs. A review of narratives helped identify the 320 vessels within that set that were documented to have contacted bridges.[5]

Table 4 depicts summary dimension data for those vessels. The availability of various dimension data varied. For example, tonnage and length data were available for more than 90% of the vessels; however, breadth and depth data were only available for about 73% of vessels.[6] Overall, there was substantial variability in the sizes of vessels that contacted bridges.

[5] For example, if only one vessel in a group of towed vessels contacted the bridge, only that vessel was included in the dimension analysis. Vessels that were transiting the area at the time of the IIA or were otherwise involved but did not contact bridges were also excluded. Finally, in some cases, the narrative did not clearly state which vessel contacted the bridge. In such cases, all vessels were excluded.

[6] For tonnage data, investigators documented International Convention on Tonnage, subpart B, gross tonnage when it was available. In cases where it was not available, subpart C or D gross tons or simplified gross tons were documented.

Table 4. Dimension data summary statistics for large-class vessels involved in BAs between 2002 and 2023.

	Gross Tonnage	Length (ft.)	Breadth (ft.)	Depth (ft.)
Vessels with Data Available	302	308	232	233
Minimum	3	13.1	10	3
Maximum	131771	1192.8	158.1	104.3
Average	17122.4	409.2	68.2	33.8
Standard Deviation	23384.6	309.9	38.6	26.1

Figure 7 depicts the average gross tonnage of vessels involved in large-class vessel BAs by year and shows that there was no clear trend in the average gross tonnage of vessels that contacted bridges over that period. Figure 8 shows a scatterplot of length and breadth data for the 232 vessels with available information and shows that the majority of vessels that contacted bridges during the period 2002 through 2023 were smaller than the *Dali*.

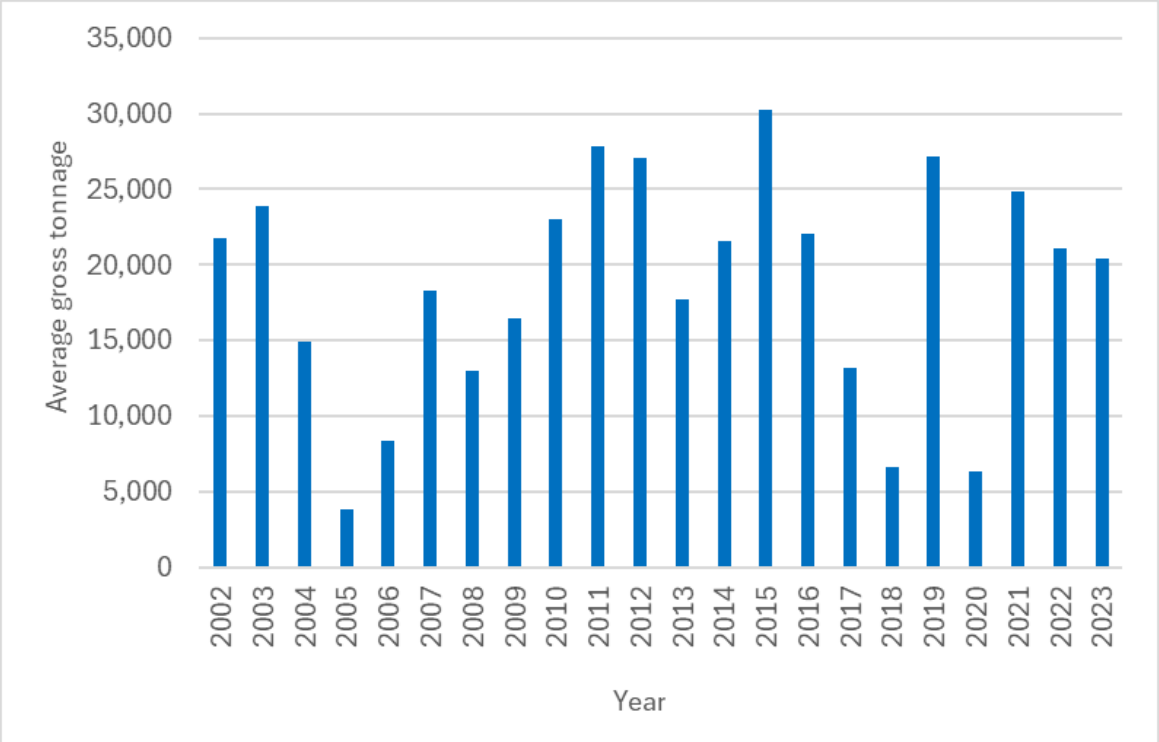

Figure 7. The average gross tonnage of vessels involved in large-class vessel BAs, by year, between 2002 and 2023.

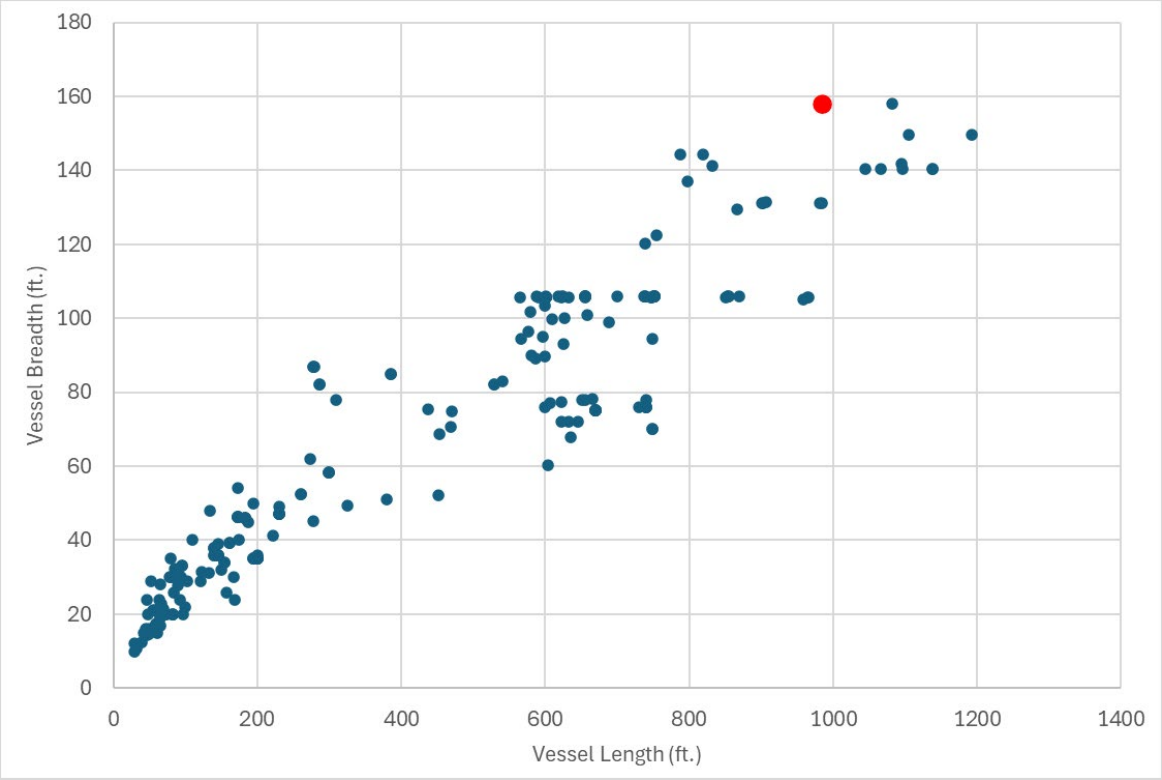

Figure 8. A scatterplot showing the length and breadth of vessels that contacted bridges between 2002 and 2023. A red dot represents the *Dali*'s dimensions for comparison.

Issues Cited in MISLE Narratives Involving Large-Class Vessel BAs

Investigators reviewed the narratives of the 328 BAs involving large-class vessels and documented various issues that were cited as causes or antecedents to vessels contacting bridges. The results are summarized in table 5. In 79 of the 328 cases (24.1%), there were no issues mentioned in the narrative, or the narrative stated the cause was unknown. For the remaining 249 cases, one or more operation-related, environment-related, vessel-related, and/or bridge-related issues were cited.[7]

In the operations-related category, the most prevalent were clearance-related issues, cited in 77 of 328 (23.5%) BA narratives, and maneuvering-related issues, cited in 69 (21.0%) narratives. In the environment-related category, the most prevalent were current, cited in 23 (7.0%) narratives, and wind, cited in 20 (6.1%) narratives. In the vessel-related category, the most prevalent were loss of propulsion/power, cited in 15 (4.6%) narratives, and incorrect vessel documentation, cited in 10 (3.0%) narratives. Finally, in the bridge-related category, the most prevalent were materials hanging below the bridge, cited in 6 (1.8%) narratives, and incorrect bridge documentation, cited in 4 (1.2%) narratives.

[7] Some cases cited multiple issues across different categories. Consequently, the number of narrative citations listed in table 5 add up to more than 328.

Table 5. Operation-, environment-, vessel-, and bridge-related issues cited in the narratives of large-class vessel BAs between 2002 and 2023.

Operation-Related Issues	Number of BA Narratives Citing	% of BA Narratives Citing
Clearance-related	77	23.5%
Maneuvering-related	69	21.0%
Towing maneuver-related	18	5.5%
Miscommunication	12	3.7%
Attempting to avoid collision with other vessel	7	2.1%
Bridge operation-related	5	1.5%
Distraction	3	0.9%
Inexperience	2	0.6%
Other operation-related	4	1.2%
Environment-Related Issues		
Current	23	7.0%
Wind	20	6.1%
High water	6	1.8%
Other environment-related	2	0.6%
Vessel-Related Issues		
Loss of propulsion/power	15	4.6%
Incorrect vessel documentation	10	3.0%
Vessel adrift/unmoored	9	2.7%
Rudder/steering problem	3	0.9%
Other vessel-related	1	0.3%
Bridge-Related Issues		
Materials hanging below bridge	6	1.8%
Incorrect bridge documentation	4	1.2%
Bridge mechanical failure	1	0.3%
Other bridge-related	1	0.3%
Unknown or Not Available	79	24.1%

Submitted by:

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