National Transportation Safety Board
Office of Marine Safety
Washington, DC 20594

DCA22FM001

ANCHOR DISTANCE TO VESSEL AIS ANTENNA STUDY

Specialist's Study

October 7, 2023

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A. ACCIDENT

Location: San Pedro Bay, California
Date: October 1, 2021
Time: 1610 Local Time

Vessel 1: Containership *Beijing*
Vessel 2: Containership *MSC Danit*

On October 1, 2021, at 1610 local time, San Pedro Bay Pipeline controllers received the first of a series of leak detection system alarms for their subsea pipeline, which was in San Pedro Bay, 4.75 nautical miles off the coast of Huntington Beach, California. At 0604 on October 2, controllers shut down the pipeline. A pipeline contractor vessel crew visually confirmed a crude oil release at 0809, and the pipeline operator then initiated an oil spill response.

B. ANCHOR DISTANCE TO VESSEL AIS ANTENNA STUDY

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C. OVERVIEW

A postaccident examination of the subsea pipeline found a leak along its top within a displaced section of the pipeline. Additionally, scarring from apparent anchor dragging was on the seafloor near the leak location. Investigators looked to identify vessels that could have dragged anchor and damaged the pipeline. The Coast Guard and NTSB reviewed automatic identification system (AIS) data for the area surrounding the damage location. The review identified two vessels that crossed the pipeline on January 25, 2021, near the damage location in a manner consistent with anchor dragging (within the timeframe between the last undamaged pipeline survey and the crude oil release). The containerships *Beijing* and *MSC Danit* were the vessels that potentially dragged their anchors.

The location of the displaced pipeline was known from post-leak underwater multi-beam surveys, as was the pipeline's original position. Underwater visual surveys

also determined the exact location of the leak along the pipe. Investigators sought to determine the range of possible positions of the vessels' anchors relative to their respective AIS antenna positions and other references (centerline and bow). The AIS antennae were located aft of the bow above the bridge on each vessel. This study may allow for a future comparison of the potential anchor locations from examined vessels to the pipeline and bottom scarring at various historical vessel AIS antennae positions at the time the vessels dragged anchor.

D. SUMMARY

The results showed that a profile-only graphical analysis for the *Beijing* at a design draft of 13.0 meters, with 5 shots "on deck" and the anchor tending directly off the bow, and chain leads from 60° to a taut chain (no catenary) would result in distance range from the anchor to the AIS antenna from 354.4 meters (1,163 feet) to 366.6 meters (1,203 feet) (see figure 1). Comparing this to an alternate 9.4-meter draft, rather than the design draft of 13.0 meters, would produce nearly similar distances—within about a meter or less (see figure 3). The estimates for 1.5 shots in the water, rather than 5 shots on deck, was about 4.0 meters greater for the 9.4-meter draft.

For the analysis of the *Beijing* anchor tending 76°, using an overhead graphical analysis (figure 1), the results showed that the distances to the AIS antenna decreased per geometry and provided distances to the vessel centerline for additional future analysis.

For the *MSC Danit* at a design draft of 14.0 meters, figure 2 shows that a profile-only graphical analysis with 8 shots "on deck," and leads from 60° to a taut chain (no catenary), the distance from the anchor to the AIS antenna would range from 332.5 meters (1,091 feet) to 347.3 meters (1,139 feet). The minimum distances, at a 60° lead for 7 shots on deck, was 305.0 meters (1,001 feet), and for 6 shots on deck at 60° was 277.6 meters (911 feet). Comparing this to an alternate 11.2-meter draft, rather than the design draft of 14.0 meters, would produce nearly similar distances—less than 2.0 meters (see figure 4).

Using the distances from the *MSC Danit* anchor to the vessel's AIS antennae locations determined from the profile analysis, a scaled overhead graphical depiction of the vessels' AIS position(s) (as the vessel may have swung about a fixed anchor and the hawse pipe) was produced. This could be used for further graphical analysis of the estimated vessel AIS position(s) from a fixed position (such as a pipeline or anchor position) on GIS or nautical charts (see figure 2).

1.0 Information For Study

Vessel general arrangement, anchor and anchor chain drawings, designed draft, anchor chain shots payed out, and general water depth information were obtained from several sources as described in tables 1 and 2 below.

Table 1. *Beijing*

	Value	Source
Draft at anchor, AIS	9.4 m (31 ft)	AIS historical data
Draft at anchor	13.0 m (43 ft) (design draft)	9,500 TEU Class Container Carrier, General Arrangement, Hyundai Heavy Industries, Dwg. No. IG-7000-201, Rev.0, 12.01.2016
Length, overall	350.6 m (1,150 ft)	" "
Vessel profile and deck drawings		" "
Vessel foredeck/hawsepipe dimensions		9,500 TEU Class Container Carrier, Mooring Arrangement, Hyundai Heavy Industries, Dwg. No. 3J-7000-024, January 6, 2006
Anchor dimensions		9,500 TEU Class Container Carrier, Standard of Hull Outfitting, Hyundai Heavy Industries, Dwg. No. 3J-7000-021, April 18, 2005
Anchor chain dimensions		Anchor Chain Cable, Hyundai Heavy Industries, Dwg. No. HD-1643-01-3, September 27, 2005
Distance: bow to AIS antenna	258.0 m (847 ft)	AIS data
AIS antenna: distance to port side	18.0 m (59 ft)	AIS data
Water depth	30.8 m (101 ft)	ENC US4CA60M data
Anchor dropped	Port	*Beijing* bell book
Shots out	5 on deck	Interviews *Beijing* second officer
Shots out	1.5 in the water	*Beijing* master statement of facts

Table 2. *MSC Danit*		
Parameter	**Value**	**Source**
Draft at anchor, AIS	11.2 m (36.8 ft)	AIS historical data
Draft at anchor	14.0 m (45.9 ft) (design draft)	MSC 14,000 TEU Containership, General Arrangement, Dwg. No. DSME DA101Z029, March 4, 2009
Length, overall	365.5 m (1,199 ft)	" "
Vessel profile and deck drawings		" "
Vessel foredeck/hawsepipe dimensions		MSC 14,000 TEU Containership, Arr't of Anchor Handling, Dwg. No. DSME DA431D001, Rev. 2, October 11, 2007
Anchor dimensions		19,500 (KGF) Anchor Assembly Drawing, High Holding Power Type Stockless Bower Anchor, Dwg. No. KHC-19500, Rev. 0, May 18, 2009
Anchor chain dimensions		MSC 14,000 TEU Containership, Anchor Chain, Dwg. No. DV431D002, Rev. 0, October 12, 2007
Distance: bow to AIS Antenna	143.0 m (469 ft)	AIS data
AIS antenna: distance to port side	35.0 m (115 ft)	AIS data
Water depth	29.0 m (95 ft)	ENC US5CA61M data
Anchor dropped	Port	*MSC Danit* bell book
Shots out	6–8 on deck	NTSB estimate based on bell book data and cadet interview

2.0 Determination of Range of Anchor Distances

A graphical analysis was used to determine the anchor distance on the bottom for both the *MSC Danit* and *Beijing*, using data from tables 1 and 2. The methodology for the graphic analysis consisted of the following.

- The outboard profile and overhead plan of the vessels were drawn in AutoCAD software by importing JPEGs of the general arrangement profiles and deck plans, and scaling to principal dimensions noted in general arrangement drawing tables.
    - The anchors were drawn similarly.

- A shot, per nautical standard, was drawn as 90 feet (27.4 meters) of chain. (Matched vessel drawings of fitted anchor chain.)

- The distance from the foredeck in front of the windlass, where a crewmember would note "shots on deck" was estimated from vessel anchor handling or outfitting drawings plans, as was distance of the anchor chain through the hawsepipe. This determined the amount of chain from the bottom of the hawsepipe to where it would be called "shots on deck."

- To establish a range of possible anchor positions as the vessel might surge or move in wind and seas at anchor, anchor leads were run from the bottom of the hawsepipe at four angles: 60°, 45°, 30° and taut (straight run to anchor at limit of reported shots payed out).

- The catenaries for each lead were drawn with straight-line segments between each shot for simplicity.

- The draft of the *Beijing* was chosen to be the design draft, as the AIS data draft appeared to be inaccurate. However, the AIS draft is shown, and anchor distances generated from the lighter draft are plotted for comparison.

- Overhead (plan) views were developed for the *MSC Danit* and *Beijing* based on the distances to the various anchor positions determined from the profile graphical analysis directly ahead of the vessel bows.

    - Additionally, the *MSC Danit* had an overhead view of the arc of the vessel's AIS position plotted based on fixing the various positions of the anchor directly ahead of the bow and rotating the vessel as if it were swinging around the fixed anchor and the hawespipe.

    - Additionally, the *Beijing* was modeled in overhead view (plan) with the anchor chain directly off the bow and at an angle of 76°, based on separate analysis by the NTSB estimating that at one point in the dragging sequence the vessel potentially dragged anchor with a course over ground of about 70° with a heading of 326°. An additional distance to the longitudinal centerline of the vessel at the location of the vessel's hawsepipe was also determined.

2.1 Accuracy and Assumptions

The graphical analyses in Figures 1–4 are subject to two factors: accuracy and assumptions.

- Accuracy of the inboard vessel profile drawings used (must be actual representation)

- Accuracy provided by the resolution of the reference drawings
- Accuracy of the estimated anchor chain catenaries
- Accuracy of the crews' estimates of the anchor chain length from the windlass/on deck to the bottom of the vessel hawsepipes
- Accuracy of the recollection of the number of shots payed out by the vessel crews
- Assumption the vessels were at even keel and static in waves/wind
- Accuracy of vessel drafts.

Efforts were made to check for proper scaling and to minimize uncertainties throughout the graphic analysis, although all factors listed above can have some effect on the range of anchor distances in this report. However, the number of shots payed out and the catenary modeling have the most significant impact on the distance range.

3.0 Results

Tables 3 and 4 summarize the distance ranges established from the graphical analysis:

Table 3. Anchor Distance from Bow and AIS Antennae (Directly ahead of Bow)

Vessel	Shots, Chain Lead Angle	To Bow	To AIS Antenna
MSC Danit 14.0 m design draft	8 shots on deck, taut chain	204.2 m (670 ft)	347.3 m (1,139 ft)
	8 shots on deck, 60° lead	189.5 m (618 ft)	332.5 m (1,091 ft)
	7 shots on deck, taut chain	176.2 m (578 ft)	319.2 m (1,047 ft)
	7 shots on deck, 60° lead	162.0 m (532 ft)	305.0 m (1,001 ft)
	6 shots on deck, taut chain	147.9 m (485 ft)	290.9 m (954 ft)
	6 shots on deck, 60° lead	134.6 m (442 ft)	277.6 m (911 ft)
MSC Danit 11.2 m AIS draft	8 shots on deck, taut chain	203.7 m (668 ft)	346.7 m (1,137 ft)
	6 shots on deck, 60° lead	132.4 m (434 ft)	275.37 m (903 ft)
Beijing 13.0 m design draft	5 shots on deck, taut chain	108.6 m (356 ft)	366.6 m (1,203 ft)
	5 shots on deck, 60° lead	96.4 m (316 ft)	354.4 m (1,163 ft)
	1.5 shots in the water, 45° lead	20.8 m (68 ft)	278.8 m (915 ft)
Beijing 9.4 m AIS draft	5 shots on deck, taut chain	107.5 m (353 ft)	365.5 m (1,199 ft)
	5 shots on deck, 60° lead	96.3 m (316 ft)	354.3 m (1,162 ft)
	1.5 shots in the water, 45° lead	24.4 m (80 ft)	282.4 m (927 ft)

Table 4. Anchor Distance from Bow and AIS Antennae (76° off Port Bow)				
Vessel	**Shots, Chain Lead Angle**	**To Bow**	**To AIS Antenna**	**To Vessel Centerline**
Beijing 13.0 m design draft	5 shots on deck, taut chain	132.0 m (433 ft)	299.0 m (981 ft)	135.0 m (443 ft)
	5 shots on deck, 30° lead	129.2 m (424 ft)	297.2 m (975 ft)	124.7 m (409 ft)
	5 shots on deck, 60° lead	120.0 m (394 ft)	291.4 m (956 ft)	122.9 m (403 ft)

Figures 1–4 depict the leads, shots out, and anchor locations for the *MSC Danit* and *Beijing*.

Figure 1 . *Beijing,* anchor leads with shot count, 13.0-meter draft (AutoCAD plot).
Figure 2. *MSC Danit*, anchor leads with shot count, 14.0-meter draft (AutoCAD plot).
Figure 3 . *Beijing,* anchor leads with shot count, 9.4-meter draft (AutoCAD plot).
Figure 4. *MSC Danit*, anchor leads with shot count, 11.2-meter draft (AutoCAD plot).

Figure 1. *Beijing* anchor leads with shot count, 13.0 meter draft (AutoCAD plot)

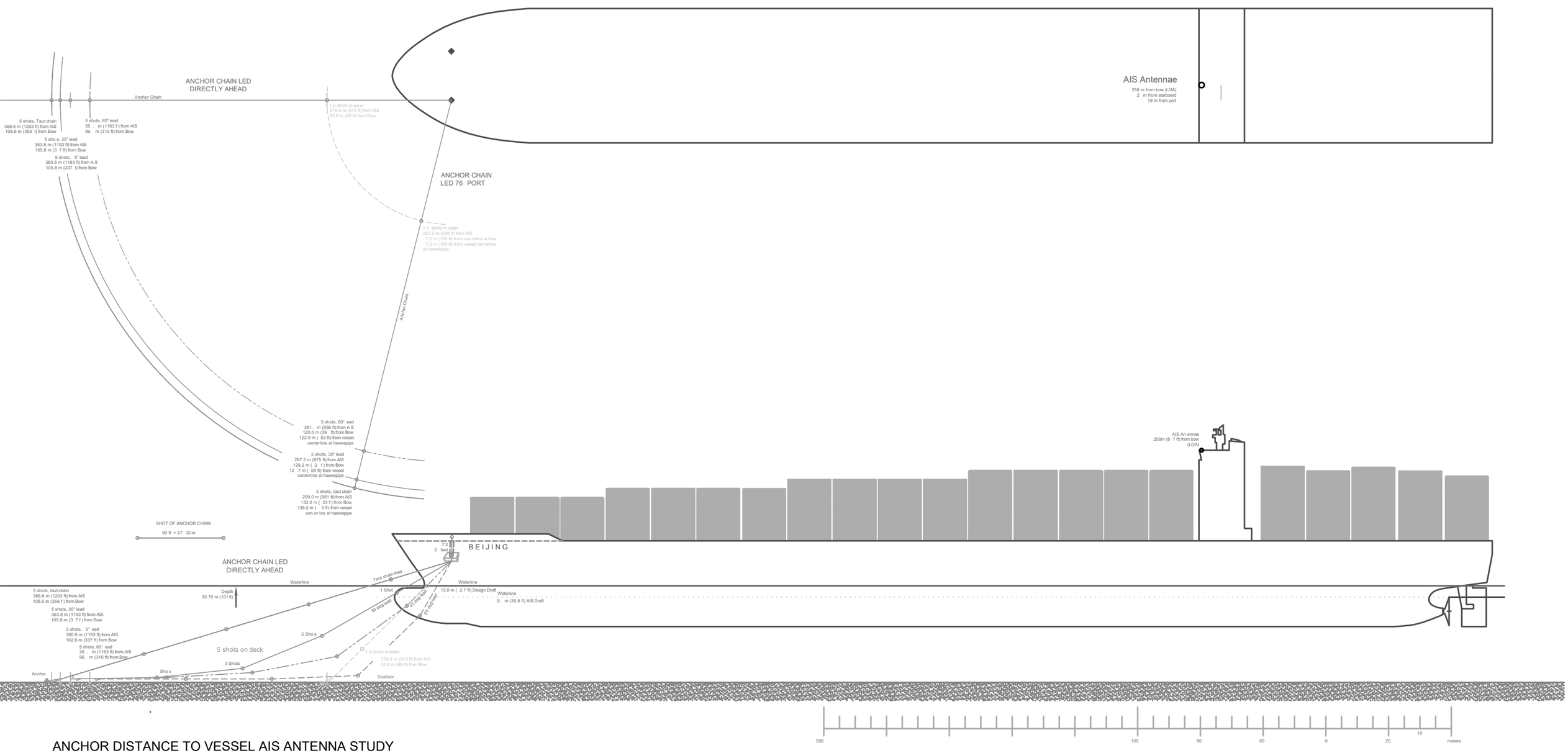

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Figure 2. MSC *Danit* anchor leads with shot count, 14.0 meter draft (AutoCAD plot)

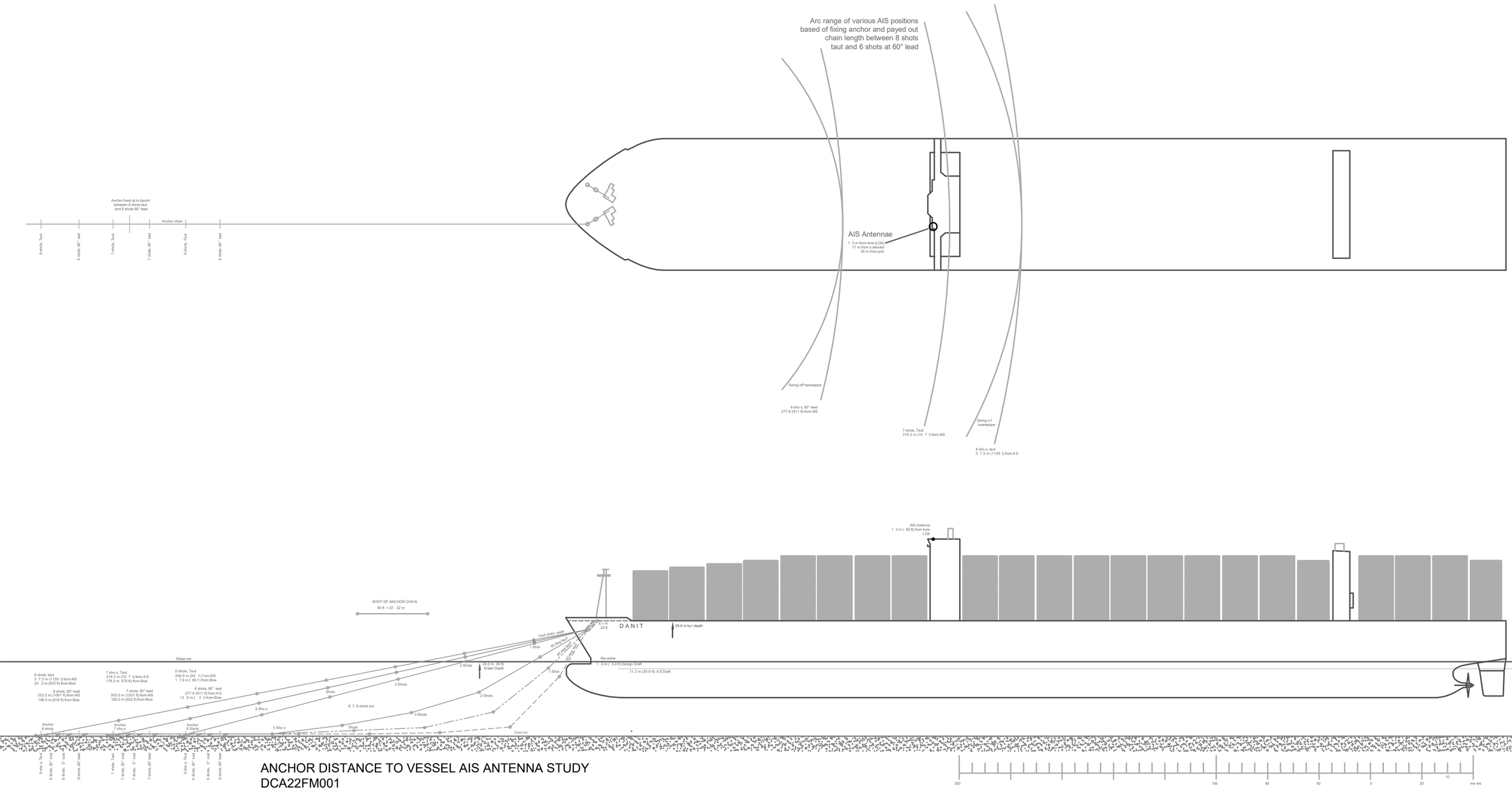

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Figure 3. *Beijing* anchor leads with shot count, 9.4 meter draft (AutoCAD plot)

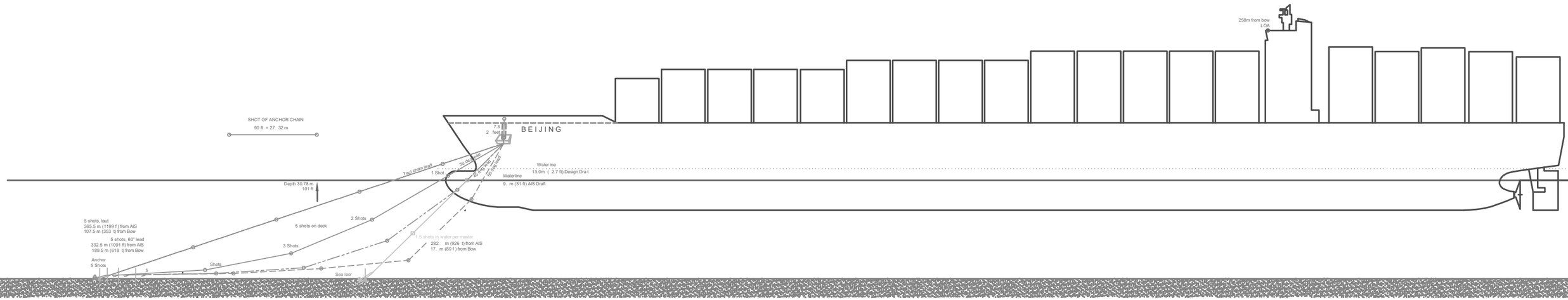

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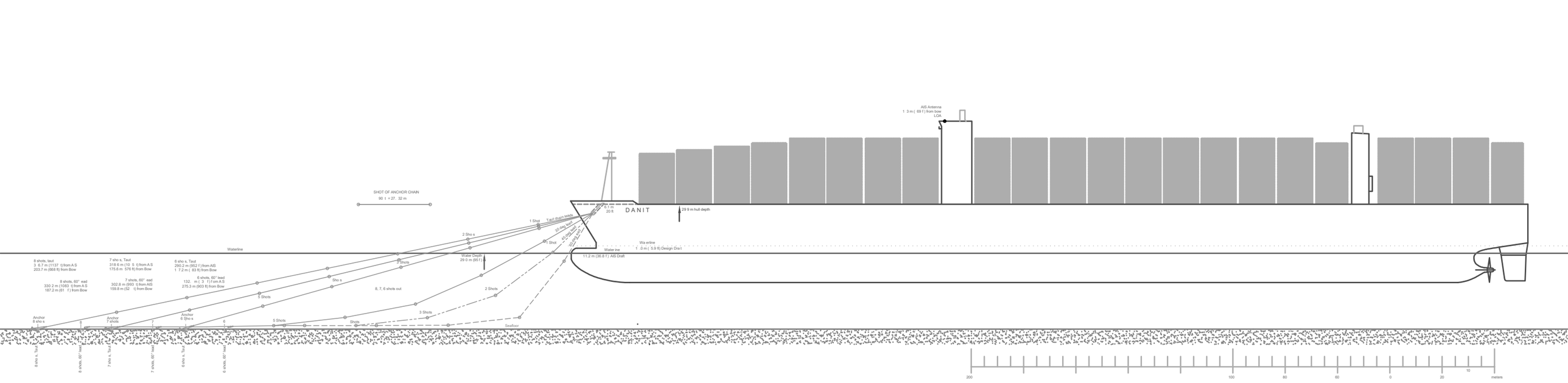
Figure 4. MSC *Danit* anchor leads with shot count, 11.2 meter draft (AutoCAD plot)



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