PROJECT SANDSTONE

On the Trail of the *Tae Yang*

AIS Spoofing and North Korean
Coal Smuggling

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Methodology and Disclaimer on Sources

For this report, RUSI and CNS research teams relied extensively on data providers for access to information transmitted by the Automatic Identification System (AIS) transponders installed on multiple vessels. The research team sought both raw and processed AIS data from Polestar Space Services and IHS Markit. Comparison of the datasets allowed the research teams to sort out instances where software might seek to ‘correct’ data and thereby inadvertently misconstrue information about a vessel’s location or identity. Despite these efforts, the data set collected may not be accurate. It is imperative that the findings in this report be considered in this context.

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Executive Summary

LITTLE SUBSTANTIVE progress towards denuclearisation has been made in the year since US President Donald Trump first met North Korea’s leader Kim Jong-un for their Singapore summit. This has been exacerbated by North Korea’s continued ability to earn foreign revenue that may be used to either directly fund or offset spending on the country’s nuclear and missile programmes. This ability can be attributed both to the inconsistent implementation of UN sanctions on North Korea and to North Korea’s sophisticated sanctions-evasion techniques.

This report tracks the activities of the Tae Yang, one of North Korea’s largest bulk carriers that it relies on to export commodities like coal that provide revenue for the regime in Pyongyang. Researchers from RUSI and the James Martin Center for Nonproliferation Studies (CNS) used vessel location and identification data from Automatic Identification System (AIS) transmissions by the Tae Yang, along with satellite and open-source imagery, to chart the vessel’s shipment of coal from North Korea to a presumed ship-to-ship transfer in the Gulf of Tonkin. In doing so, they uncovered a series of identities used by the Tae Yang to mask its possible involvement in illicit activity.

All of the identities assumed by the Tae Yang had one thing in common: they used what is supposed to be a unique identification number assigned to another vessel, the Krysper Singa. This exposed the limitations of existing vessel-tracking platforms, as the AIS transmissions broadcast by the Tae Yang under its assumed identities were aggregated with legitimate transmissions by the Krysper Singa. This led the joint RUSI–CNS research team to adopt a methodological approach comparing raw and processed AIS data. This approach, with its demonstrated utility tracking the Tae Yang, may be used to identify other vessels using identity falsification techniques to mask illicit activity.

While this report and research like it may assist in the identification of vessels engaged in illicit activity, the onus remains on UN member states to implement and enforce sanctions against North Korea. Until that happens, expect the Tae Yang – and vessels like it – to remain at large.

This investigation is the third in a series that focuses on understanding the corporate ownership structures that support North Korea’s illicit networks, and on increasing the breadth and depth of publicly available information on these structures. It is a product of RUSI’s Project SANDSTONE, which uses open-source intelligence techniques to uncover and report actionable information on proscribed North Korean activities. We gratefully acknowledge the support of Global Affairs Canada in funding the research that has led to this report.

1. This report does not allege that the Krysper Singa is involved in sanctions-evading activity or has acted improperly in any way.
**Introduction**

On 26 March 2018, a 146-metre-long North Korean cargo ship named the *Tae Yang* disappeared from commercial Automatic Identification System (AIS) platforms while docked at a coal berth in North Korea’s port of Nampo. From that date, commercial AIS platforms ostensibly hold no record of the *Tae Yang*’s movements.

23 days later – after a journey of over 3,000 kilometres – the *Tae Yang* transferred a cargo of coal to an unidentified vessel off the coast of Vietnam, in what the UN Panel of Experts identified as a violation of multilateral sanctions levied on Pyongyang following its tests of two ICBMs in July 2017.

Despite UN Security Council Resolutions prohibiting North Korea’s exports of coal and iron ore, a fleet of cargo ships like the *Tae Yang* have continued to move commodities to buyers and brokers in countries such as China, Vietnam, Indonesia, Malaysia and South Korea. These exports provide a critical source of revenue for North Korea, with a 2017 estimate placing the value in excess of one billion dollars a year.

Originally installed to reduce accidents at sea, the International Maritime Organization (IMO) has required AIS transponders to be fitted aboard ships over a certain tonnage since 2004. Since then, AIS transponders have become increasingly important across the maritime sector for those looking to monitor their fleets and those of their customers. This growth of positional data has drastically increased transparency in the industry and made life more difficult for those hoping to operate in the shadows.

Often described in the shipping industry as ‘going dark’, intentionally switching off AIS transponders has become an increasingly common practice among members of North Korea’s shipping fleet such as the *Tae Yang*.
On the Trail of the Tae Yang. Hard-pressed by international sanctions and facing increased scrutiny from regional authorities and port state control organisations, flag states and a variety of maritime services providers, North Korea’s merchant fleet has adapted in order to keep waterborne trade flowing in and out of the country.

Like many other illicit operators, North Korea has used flags of convenience to disguise the nationality of its vessels, front companies to obscure ultimate ownership, and trusted foreign managers to operate vessels on its behalf. For vessels actively engaged in the trade of sanctioned North Korean goods, commodities or military supplies, openly transmitting positional AIS data now offers very little upside. Yet going dark in busy sea lanes or the territorial waters and ports of other countries also poses significant risks, especially for large vessels that may attract unwanted attention by doing so.

As a result, some members of the country’s shipping fleet have developed evasive measures designed to camouflage their identity while still transmitting AIS data. Research published by the UN Panel of Experts has detailed some instances of these AIS spoofing techniques, highlighting the great lengths to which North Korea’s illicit shipping networks will go to evade sanctions.

This report, the result of a joint investigation by RUSI and CNS, details one such case and has attempted to piece together the case of the Tae Yang since it disappeared off AIS tracking platforms in 2018.

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11. Leo Byrne, ‘Nearly 50 North Korea-Linked Ships Reflag as Tanzanian’, NK Pro, 7 October 2016.
A Phantom Ship

In March 2019, an unknown vessel travelled from the Gulf of Tonkin in Vietnam to Nampo, North Korea. It was transmitting via its AIS the Maritime Mobile Service Identity (MMSI) number registered to a vessel called the Krysper Singa, an unregistered vessel name, Bong San, and an invalid IMO number.

The Krysper Singa is a 61-metre-long Mongolian-flagged chemical tanker operated out of Singapore. However, the ship transmitting in March 2019 reported its length as 146 metres and its breadth as 21 metres. Its AIS transmission declared the vessel to be a cargo ship, but commercial satellite imagery could confirm that the vessel’s identity was unavailable.

Roughly two months later, in May 2019, an unknown vessel again visited Nampo, North Korea (see Figure 1), using the MMSI number registered to the Krysper Singa, an unregistered vessel name, Plot, and an invalid IMO number. Again, the vessel’s stated length was 146 metres, its breadth 21 metres, and its AIS signal declared it to be a cargo ship.

On this occasion, however, the location of the vessel’s AIS transmissions aligned with available satellite imagery of a vessel exiting the West Sea Barrage at Nampo on 22 May 2019. Cross referencing the actual vessel dimensions (length 146 metres and breadth 21 metres) and configuration (three cranes and five cargo bays) with known North Korean vessels using the IHS Markit Sea-web platform suggests that the unknown vessel was, in fact, the Tae Yang (IMO No. 8306929).

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17. Raw AIS data provided by Polestar Space Services shows a number of transmissions under this name.

18. The IMO’s Global Integrated Shipping Information System contains no record of the vessel name ‘Bong San’ or IMO number.

19. AIS data provided by IHS Markit and Polestar Space Services.

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Figure 1: Vessel Identified as the *Tae Yang* Leaves Nampo, North Korea on 22 May 2019

Satellite imagery analysis confirms the vessel as having an approximate length of 146 meters and breadth of 21 metres (see Figure 2). It also had other clearly identifiable features: three cranes and five cargo bays.
Figure 2: Close-up of the *Tae Yang* at the Nampo West Sea Barrage on 22 May 2019

Source: Planet Labs.

Figure 3: Reference Image of the *Tae Yang*

Source: IHS Markit’s Sea-web platform.
This research found no evidence to suggest the *Tae Yang* was elsewhere when the satellite imagery above (Figures 1 and 2) was captured since the *Tae Yang* has not accurately identified itself through AIS transmissions since March 2018. Moreover, the invalid IMO numbers (8806929 and 8806920) included in the AIS transmissions using the *Krysper Singa*’s MMSI number closely resemble that of the *Tae Yang* (8306929). This is consistent with previous efforts by North Korea to conceal the identity of its vessels.

**Caught on Camera: Contraband Cargo**

Satellite imagery also places the *Tae Yang* at a coal berth in North Korea’s port of Songnim on 20 May 2019. AIS transmissions using the *Krysper Singa*’s MMSI number were received showing a vessel arriving at that berth less than two days prior and transmitting at this location until the early hours of 20 May 2019 (see Annex 1). Taken together, these observations strongly suggest that the *Tae Yang* was loaded with coal when it was spotted departing North Korea on 22 May 2019 at the Nampo West Sea Barrage (see Figure 4).

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21. The Polestar Space Services, IHS Markit and Marine Traffic platforms contain no records of the *Tae Yang*’s movements under its official registered identity since that date.


23. See Annex 1 for an overlay of satellite imagery and AIS data showing the *Tae Yang* loading coal at Songnim and then beginning its voyage abroad at the Nampo West Sea Barrage.
Based on the comparative cargo capacities listed in IHS Markit’s Sea-web platform of the *Tae Yang* and the *Wise Honest* (IMO No. 8905490) – the North Korean vessel detained in Indonesia in April 2018 with approximately $2,990,000 worth of coal\(^\text{24}\) – the *Tae Yang* could have been carrying a cargo that could be worth approximately $1.6 million.\(^\text{25}\)


\(^{25}\) Calculated using cargo volumes (grain) recorded by IHS Markit for the *Wise Honest* (38,239 m\(^3\)) and *Tae Yang* (21,152 m\(^3\)), along with the contract price for the coal carried by the *Wise Honest* (see preceding footnote). This calculation values the cargo of the *Tae Yang* at $1,653,926.10, assuming that the *Tae Yang* was filled to the same capacity (percentage of total cargo volume) as the *Wise Honest*. This calculation does not account for fluctuation in the price of coal, nor does it assume that North Korean-origin coal is sold at market price.
AIS transmissions associated with the *Tae Yang* (but still using the MMSI number of the *Kry sper Singa*) show the vessel once again headed towards the Gulf of Tonkin after leaving Nampo on 22 May 2019.26 This suggests that the cargo of the *Tae Yang* was for export purposes in violation of UN Security Council resolution 2371 (2017).27

**Figure 5: Voyage of the *Tae Yang* after Loading Coal in Songnim**

Voyage from the DPRK by the *Tae Yang*
21 May - 30 May 2019

*Source: AIS data provided by Polestar and IHS Markit. Direction of vessel shown from light to dark shading.*

This would not be the first time that the *Tae Yang* has been implicated in the illicit export of coal. The vessel was listed as having shipped coal from North Korea to the Gulf of Tonkin in the most recent report.

26. AIS data provided by Polestar Space Services and IHS Markit suggests that the vessel identified in this report as the *Tae Yang* also undertook earlier voyages to the Gulf of Tonkin. These are believed to include two trips from North Korea to the Gulf of Tonkin (23 February–2 March 2019 and 26 March–8 April 2019, dates approximate) and two returns from the Gulf of Tonkin to North Korea (15 March–26 March 2019 and 10 May–21 May 2019, dates approximate). Earlier activity, again based on AIS data by Polestar and IHS Markit, indicates that the vessel may have been at Zhoushan, China, on or about 14 January 2019 and 6 February–13 February 2019.

27. Operative paragraph 8: ‘Decides that the DPRK shall not supply, sell or transfer, directly or indirectly, from its territory or by its nationals or using its flag vessels or aircraft, coal, iron, and iron ore, and that all States shall prohibit the procurement of such material from the DPRK by their nationals, or using their flag vessels or aircraft, and whether or not originating in the territory of the DPRK’. UN Security Council Resolution 2371, 5 August 2017, S/RES/2371.
by the UN Panel of Experts tasked with overseeing implementation of and compliance with UN sanctions on North Korea.28 The two instances detailed in the Panel report, allegedly occurring between March and October 2018, include ship-to-ship29 transfers prohibited by UN Security Council Resolution 2375 (2017).30 Two months later, in December 2018, the *Tae Yang* was captured on commercial satellite imagery loading coal in North Korea’s port of Nampo, although the ship’s destination – in that case – remains unknown (see Figure 6).


29. Ship-to-ship transfers are commonly used in attempts to evade sanctions on North Korea, as they allow a foreign party to transfer cargo – commonly coal or petroleum – with a North Korean counterparty at sea where countries often have the weakest capability to enforce their national laws and obligations to the UN.

30. Operative paragraph 11: ‘Decides that all Member States shall prohibit their nationals, persons subject to their jurisdiction, entities incorporated in their territory or subject to their jurisdiction, and vessels flying their flag, from facilitating or engaging in ship-to-ship transfers to or from DPRK-flagged vessels of any goods or items that are being supplied, sold, or transferred to or from the DPRK’. UN Security Council Resolution 2375, 11 September 2017, S/RES/2375, p. 3.
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**Figure 6:** The *Tae Yang* Loading Coal in North Korea’s Port of Nampo on 7 December 2018

Source: TerraServer, Digital Globe.

The *Tae Yang* is capable – as a Freedom Mark II cargo vessel[^31] – of conducting ship-to-ship transfers using its horizontal slewing cranes to load and unload cargo.[^32] This suggests that the presumed coal with which the *Tae Yang* was observed exiting North Korea in May 2019 may have been intended for such a transfer to another currently unknown vessel.

A potential ship-to-ship transfer by the *Tae Yang* fits with emerging trends in North Korean sanctions evasion. The UN Panel of Experts has identified a ‘massive increase in illegal ship-to-ship transfers of petroleum products and coal’.[^33]


The route too is familiar. Several other North Korean and foreign-flagged ships have conducted a similar journey after loading coal in North Korea.\textsuperscript{34} One of these, the North Korean-flagged \textit{Ka Rim Chon},\textsuperscript{35} is another Freedom Mark II vessel and a sister ship of the \textit{Tae Yang}.\textsuperscript{36}

AIS Camouflage and Fake AIS Identities

North Korean vessels often seek to hide their identity either through disabling their AIS transponders or by manipulating transmitted data to assume a false identity and thereby conceal a vessel’s ties to North Korea.\textsuperscript{37}

The false identity assumed by the \textit{Tae Yang} is particularly problematic. This is, in part, due to its use of the \textit{Krysper Singa}’s MMSI number. Use of that theoretically unique identification number may lead AIS tracking systems to aggregate the AIS transmissions of the \textit{Tae Yang} with legitimate signals sent by the \textit{Krysper Singa}. This is because those tracking systems often clean and correct data streams that contain significant amounts of noise. These cleaning processes are an essential feature of commercial AIS tracking systems designed to provide tracking services for shipping companies and stakeholders in the international maritime industry as they filter out anomalous or faulty transmissions.

However, that anomalous data may also include evidence, like that uncovered for this report, of false identities used to conceal alleged sanctions violations. When that evidence is only partially filtered out, it can create additional problems: when AIS tracking platforms filtered out the unregistered names used above by the \textit{Tae Yang} but not the locations associated with those transmissions, they inadvertently and incorrectly linked the real \textit{Krysper Singa} to sanctions violations committed by the \textit{Tae Yang}. This was an issue encountered at multiple stages in the preparation of this report and necessitated examining both processed AIS data provided by IHS Markit and raw AIS data obtained through Polestar Space Services.\textsuperscript{38} Comparison of the accounts helped to piece together the narrative detailed above.

Further comparison of unprocessed AIS data from IHS Markit and Polestar Space Services indicates that the operators of the \textit{Tae Yang} have also transmitted AIS signals using a number of fake ship names and IMO numbers. Since January 2019, the \textit{Tae Yang} appears to have transmitted at least five separate ship names – \textit{Yang U}, \textit{Jia Yuan}, \textit{Yang I}, \textit{Bong San} and \textit{Plot} – and two IMO numbers, 8806929 and 8806920.\textsuperscript{39}

These frequent changes while transmitting on the \textit{Krysper Singa}’s MMSI number have enabled the \textit{Tae Yang} to effectively camouflage its trips to North Korea and the Gulf of Tonkin, hiding its AIS signals inside the data stream emitted by the \textit{Krysper Singa}.

\textsuperscript{34} Ibid., p. 21.
\textsuperscript{35} Ibid.
\textsuperscript{38} See ‘Methodology and Disclaimer on Sources’ at the outset of this report.
\textsuperscript{39} Raw AIS data provided by Polestar Space Services.
Figure 7: Names, MMSI and IMO Numbers Used by the Tae Yang and the Krysper Singa

Despite swapping between names and IMO numbers, the uncorrected AIS data from Polestar Space Services shows that the Tae Yang’s transmissions have consistently included the same MMSI number (457417000), call sign (T3LQ2) and dimensions. These data points therefore remain constant across the transmissions made by the Tae Yang on the Krysper Singa’s MMSI number and indicate that the same AIS transponder is being reprogrammed to transmit different names and IMO numbers even while at sea.

Identity Spotlight: Yang I

The conclusion that the Tae Yang has consistently broadcast using the Krysper Singa’s MMSI number is supported by activity undertaken under the identity of the Yang I. AIS transmissions under that name and featuring the dimensions of the Tae Yang and the MMSI number of the Krysper Singa show multiple trips from North Korea to the Gulf of Tonkin and vice versa.40 The voyage occurring roughly 15 March–26 March 2019 is of particular note (see Figure 8).

40. Note that the pattern of behaviour matches that of the Tae Yang after being observed loading coal at Songnim, 20 May 2019, possibly indicating the Yang I identity may have been used to mask illicit export of coal.
A photo taken on 18 March 2019 of a ship sailing as the Yang I off the coast of China shows a vessel matching the physical characteristics of the Tae Yang. Its location also matches the record of AIS transmissions using the MMSI number of the Krysper Singa and claiming the Yang I identity, displayed below (see Figure 9). This appears to confirm that the AIS transmissions attributed to the Yang I identity were actually those of the Tae Yang. The image also shows the ship sitting high in the water, indicating the Tae Yang is unladen, a fact consistent with a possible coal run to the Gulf of Tonkin.

Figure 9: The *Tae Yang* Sailing as the *Yang I* off the coast of China on 18 March 2019

Source: Shipspotting.com.

The image may also indicate that the operators have painted over or hidden other identifying features of the *Tae Yang* such as the ship’s name, flag and home port, behaviour previously documented by the UN Panel of Experts in the context of sanctions evasion.42

North Korea’s identity falsification tactics, as exemplified in this report by the *Tae Yang*, make it difficult to affirmatively identify North Korean vessels. Absent satellite or open source imagery corresponding with the vessel’s AIS transmissions, it would have been very difficult to identify the *Tae Yang* as the vessel exporting coal from North Korea in December 2018, and likely in March 2019.

Enduring Challenges

The case of the *Tae Yang* exemplifies some of the challenges authorities face in monitoring compliance with UN sanctions on North Korea. Many of these challenges are technical and relate to the resources available for monitoring for North Korean illicit behavior. This report’s use of AIS data has demonstrated the inherent complexities of monitoring for suspected sanctions violations using vessel tracking software. The tendency of this information to be ‘corrected’ in monitoring products can also be exploited by unscrupulous actors to hide illicit activity.

In the context of this report, commercial AIS platforms attempted to reconcile the AIS transmissions of the *Tae Yang* and the *Krysper Singa*. This meant – since the actual *Krysper Singa* transmitted more frequently – that the *Tae Yang*’s movements were effectively masked by those of the *Krysper Singa*.

AIS tracking platforms may also jettison anomalous data. In the case of the *Tae Yang*, this means that many AIS tracking platforms no longer display or return search results for the names *Bong San, Jia Yuan, Yang U* and *Yang I*. Instead, they assign positional data emitted by the *Tae Yang* when it was using these names to the identity of the *Krysper Singa*, thereby incorrectly indicating it has made journeys to North Korea. This means that illicit behaviour may be masked by innocuous activity and that legitimate actors could be falsely implicated in connection with sanctions violations.
Conclusion

Despite unilateral and multilateral sanctions making North Korea’s operating environment more difficult, the evidence given in this report suggests that the country’s merchant shipping fleet continues to find ways to trade prohibited goods internationally.

The case of the *Tae Yang* has shown the complexity of North Korea’s sanctions evasion activity, including the use of innovative AIS masking techniques which take advantage of the very mechanisms by which such data is collected, cleaned and processed. This research provides a methodology that may help to identify other North Korean-linked ships using these same techniques to disguise their activities while hiding in plain sight.

The public identification of North Korean vessels – and, where applicable, the illicit activity they are engaged in – is central to enforcing UN sanctions on North Korea. UN member states have a duty to seize, inspect and impound vessels for which there are ‘reasonable grounds’ to believe they are engaged in activity prohibited by the UN sanctions regime on North Korea. This report, backed by independent research undertaken to verify the information contained therein, may provide such grounds.

Research such as this may also help to raise awareness about AIS spoofing mechanisms and start a wider discussion about the ways in which illicit actors seek to manipulate AIS transmissions to disguise their activities.

The recent case of the *Wise Honest* has shown a willingness by the US to break new ground in the extraterritorial enforcement of sanctions, particularly pertaining to coal and other North Korean revenue-generating exports. The assumption by the US of the costs associated with impounding a North Korean vessel may make UN member states more likely to impound vessels like the *Tae Yang* sailing in their territorial waters. However, whether individual UN member states have the requisite political will to enact and enforce the restrictions mandated by UN sanctions resolutions remains to be seen. Until that happens, expect the *Tae Yang* – and vessels like it – to remain at large.
Annex 1: Satellite Imagery in the Context of AIS Transmissions

AIS transmissions from the *Tae Yang* matched with commercial satellite photography 18 May - 22 May 2019

*Source: Satellite imagery by Planet Labs; AIS data by Polestar Space Services.*
Annex 2: AIS Transmissions Showing a Possible Visit by the *Tae Yang* to North Korea and the Gulf of Tonkin

*Voyage from the DPRK by the *Tae Yang*
26 March - 8 April 2019*

*Source: AIS data provided by Polestar Space Services and IHS Markit.*
Annex 3: AIS Transmissions Showing a Possible Visit by the *Tae Yang* to North Korea and the Gulf of Tonkin

*Voyage from the DPRK by the Tae Yang*
23 February - 2 March 2019

*Source: AIS data provided by Polestar Space Services.*