MARITIME
OPERATIONAL EXPERIENCE FOR BULK CARRIERS

DNV GL sharing insights to support safe and compliant operations at minimum cost

SAFER, SMARTER, GREENER
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In challenging times like the bulk carrier market has experienced more or less since end of 2008, no one has been spared from cost-cutting initiatives. However, cost-cutting may result in reduced maintenance standards in the bulk carrier fleet. This, in turn, may lead to more frequent class and port state control (PSC) deficiencies and, ultimately, detentions or repairs involving down-time, which could be detrimental to business.

As your trusted partner for classification services, we at DNV GL constantly seek new ways to improve and to support our customers in obtaining safer and compliant operations at minimum cost. Therefore, we have now used our Big Data capabilities to pull out operational experience data from the 1,000 bulk carriers today operating under DNV GL class. The main findings are summarized in this publication, which represents one new channel in which DNV GL is sharing operational experience with the industry. Individual customers will get more detailed and customized insight reports as part of our annual Company class and PSC benchmarking reporting.
In today’s fiercely competitive market, bulk carrier operators still need to prioritize safety and quality, in addition to a strong focus on operational efficiency. These priorities are supported by DNV GL’s stated mission: safeguarding life, property and the environment. Quality is the number one priority at DNV GL, and this is one of the reasons why we are a trusted partner for bulk carrier operators when it comes to safety and compliance.

With about 4,800 highly skilled employees active in the maritime segment, we are accessible worldwide 24/7 and provide our customers with premium, cost-effective classification and advisory services. For our customers, our size means we have more surveyors, faster response times, more experts within business-critical disciplines and a wider coverage than any other classification society.

Today, DNV GL is a technology leader in the bulk carrier segment. By developing rules and maintaining cutting-edge expertise, we remain committed to strengthening our peerless reputation worldwide.

DNV GL benefits as your preferred class partner for bulk carriers:
- A dedicated Key Account Manager who is a single point of contact for your business relationship with DNV GL
- Ship Type Experts for bulk carriers in all major bulk carrier hubs around the world
- A competitive and comprehensive fee agreement covering annual fee agreements and a range of add-on services
- Direct access to dedicated class and statutory experts through our DATE - Direct Access to Technical Experts - helpdesk
- My DNV GL portal – giving you a complete overview of the class status of your entire fleet and access to DNV GL experts – anywhere, anytime
- Customer benchmark tools which we use to extract data from PSC and our class database on the quality and performance of your fleet, with annual and quarterly follow-up meetings to help you improve on targeted critical parts of your operations
- Prompt and solution-oriented troubleshooting support with some of the industry’s most highly qualified experts
- Unique knowledge of the dry bulk market, with specialized and updated rules for these vessels
- Unparalleled maritime advisory capabilities in areas with a direct impact on your bottom line

Life-cycle support by DNV GL

Our ambition is to deliver value to customers by offering services to manage the following issues:

- Safety of crew and ship
- Cost-efficient operations
- Ship availability and fit for purpose
- Compliance with regulations, Port State Control requirements and charterers’ expectations
- Crew competence development
- Protecting brand integrity
- New technology insight and regulatory foresight

DNV GL has the solutions and tools to help you manage these and other issues throughout the life cycle of your vessels, and thus supports efficient operations with minimum downtime.

Go to pages 22 and 23 to get the full overview of DNV GL services.
HOW CAN DNV GL SUPPORT YOU TO IMPROVE?

Through data mining, DNV GL provides external insight into PSC and class performance

<table>
<thead>
<tr>
<th>Lead indicators available through DNV GL</th>
<th>Customer processes</th>
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<td>No. of conditions</td>
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<td>Overdue surveys</td>
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<td>ISM findings freq.</td>
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<td>PSC findings</td>
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<td>PSC deficiency ratio</td>
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<td>Key areas deficiency ratio</td>
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<td>Main ports key areas</td>
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<td>Manager benchmark</td>
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DNV GL has taken the experiences it has gained over the decades in bulk carriers, combined it with the insights collected from studies and research and development activities, and finally applied it’s Big Data and data analytics capabilities to pull out operational experience data to ensure our customers profit from smooth Port State Control (PSC) inspections. We are now sharing these operational insights with our customers to support safer operations, and to reduce costly incidents, detentions or delays. This may also help operators to better comply with environmental regulations. DNV GL has the regulation know-how and ship-type competence required to support your operations in running efficiently in all waters around the world, and makes us your ideal partner for sustainable business.

DNV GL insight as a source for strategic guidance

Through our engagement in the classification process during the operational phase of bulk carriers, we are in the unique position to collect a considerable amount of useful data. Furthermore, we also have data from all PSC inspections world-wide which we use to enrich the performance data from our own surveyors’ observations. Our experts then analyse the data to provide a continuously updated outside view of your company’s exposure to key bulk carrier risks - all with the aim of supporting you in keeping operations running smoothly.

DNV GL database

- 13,000 ships and MOUs
- 60,000 periodical surveys
- 25,000 non-conformities
- 90,000 findings

World port state inspections

- 88,000 inspections

IHS Fairplay ship parameters

- 80,000 ships

IHS Fairplay ship incidents

- 1,700 serious incidents

DNV GL is utilizing data from different sources to support our customers in ensuring safe and efficient operations.
The mandate of Port State Control (PSC) inspectors is to check compliance with international rules and regulations. Cases of non-compliance are systematically stored and the accumulated PSC finding records represent a unique picture of the typical deficiencies on bulk carriers, covering both technical and operational issues. By analysing these findings systematically, it is possible to identify improvement areas for the worldwide bulk carrier fleet in general, for a company’s bulk carrier fleet and for individual ships in a fleet.

DNV GL has the best PSC records for bulk carriers, and also according to Intercargo statistics on deficiencies per inspection, as DNV GL has developed several initiatives to help bulk carrier owners improve on PSC. The blue line indicates DNV GL bulk carriers, the green line bulk carriers with other class.

**Significant consequences of PSC deficiencies**
The scope of inspections performed by PSC officers covers all international conventions such as SOLAS, MARPOL, Load Line and MLC.

If a deficiency is found, this may result in significant consequences:
- Ad hoc costs due to unplanned purchases and repairs
- Possible delays and off-hire times due to detentions
- Negative impact on your company rating
- Increased targeting of your ship and company by MoUs, combined with more detailed PSC inspections and increased risk for PSC detention
- Negative exposure leading to a loss of reputation
- Estimates by DNV GL indicate that the cost for a PSC detention may be as high as USD 80,000 to USD 100,000.
Main findings
Our analysis of the PSC inspections covers the DNV GL fleet of conventional bulk carrier ESP ships only; hence, forest product carriers, ore carriers, etc. are not included. PSC data from some 1,000 vessels over a five year period have been analysed, including close to 10,000 inspections resulting in almost 16,000 deficiencies and 205 detentions.

The average number of inspections per year for the DNV GL bulk carrier fleet was 2.1 and the deficiency rate per inspection was 1.67 – which is significantly better than the industry average, and actually better than for the bulk carriers classed by any other class society. This is also consistent with the annual reports from Intercargo, which have shown a similar trend for the last five years.

The detention rate has been fairly stable at about 2.0% detentions per inspection. If we compare this with the worldwide PSC statistics, bulk carriers have a detention ratio of 2.7. Thus, DNV GL customers have achieved a compliance level higher than the other players in the bulk carrier segment.

The top deficiency categories (in order of frequency) found by PSC inspectors on the DNV GL bulk carrier fleet reflects a well-known picture:
- Fire safety
- Safety of navigation
- Certificates and documentation
- Life-saving equipment
- Working & living conditions
- Pollution prevention
- Emergency systems
- Structural condition
- Water/Weathertight condition
- Propulsion & auxiliary machinery

The deficiencies in these categories represent more than 50% of the PSC deficiencies, which corresponds to the general picture seen also for the worldwide fleet. At the same time, when we look at the top detainable PSC deficiencies, we can observe that over the last years, there has been a much stronger focus on ISM because of the New Inspection Regime (NIR) in the biggest PSC regimes (Paris and Tokyo MoUs).
Our analysis shows that on bulk carriers in DNV class, deficiencies related to fire safety is the most common finding type. Within this category, the most frequent findings are related to:

- Fire detection and alarm systems
- Fire fighting equipment
- Fixed fire extinguishing installations
- Fire prevention structures
- Fire dampers

Consequences of PSC deficiencies related to fire safety

Consequences of defective fire detection and alarm systems:
- Late detection of fire, which means that an important safety barrier is defect
- Delay of the fire fighting and thereby an increased safety risk for crew

Consequences of defective fire fighting equipment and fire dampers:
- Ineffective means to distinguish the fire
- Portable equipment/fire hoses not available in case of emergency may cause smaller fire outbreaks to spread rapidly
- Inoperative fire dampers may allow the fire to spread through ventilation channels

Consequences of defective fixed fire extinguishing installations:
- In case of a fire, the system may not be able to put out the fire
- Crew may try to extinguish the fire manually - increasing the risk of injuries/fatalities
- Increased extent of damage to the ship

How you can improve with DNV GL

Many of the PSC findings related to fire safety are typical maintenance issues, therefore it is recommended to carefully review the planned maintenance system (PMS) and ensure proper maintenance procedures are incorporated and implemented. Regular maintenance routines should include practical guidance to crew, especially for focus areas.

Also, focused campaigns to improve awareness and competence of crew on the most frequent findings have proven effective, usually in combination with practical training and familiarization with both the operation and maintenance of related equipment. Regular emergency drills should also be part of normal ship management procedures.

To support such awareness campaigns, DNV GL has issued a special guidance document and an instruction video on fire safety in the engine room, available on YouTube and at www.dnvgl.com. This guidance material is a supplement to MsC.1/Circ.1321 guidelines for measures to prevent fires in engine rooms and cargo pump rooms. It especially stresses that the crew’s attitude to general cleanliness is very important and plays a crucial role in reducing the risk of fire. Furthermore, equipment and material should be regularly checked to confirm that the insulation has been correctly installed and has not absorbed any flammable oils.

DNV GL insights

The high number of PSC deficiencies, and even detention, related to fire safety have significant consequences on operational cost, but even more important: they may have a severe impact on the safety of the crew, the ship, crew and its cargo. For instance, delayed fire detection in an engine room may have catastrophic consequences, especially since fire fighting equipment may often have further built-in time delays.

DNV GL analysis of both PSC and class findings, as well as statistics from insurance companies, indicate that the majority of fires on ships originate in the engine room. Flammable oil leaks coming into contact with hot surfaces are by far the most common reason for engine room fires. Another main contributor to fire and explosion risk is excessive blow-by causing scavenging space fires or crankcase explosions.
The condition of navigational equipment and ECDIS is a PSC issue that has a particularly high relevance for bulk carriers, as seen in recent years.

Insights gained by DNV GL from industry observations show that deficiencies in the category “Safety of navigation” are the second most frequent deficiency type after “Fire safety”. Lights, shapes, sounds, the voyage or passage plan, and compass corrections are the top elements here. Lights and sounds are typically high-frequency and low-impact issues, while voyage or passage plan is a higher risk finding.

Another point to remember is that a PSC inspection normally starts with focus on documents and record-keeping and that deficiencies in this category will justify a more detailed inspection by the PSC officer.

Also for ECDIS (Electronic Chart Display and Information System), we see a high number of PSC deficiencies. Typical defects include the use of non-approved equipment, ship officer not familiar with equipment, and power supply not as required. Australia has been especially active in this category.

Significant increased risk for grounding and collision due to defects related to radar, ECDIS, charts, and passage plans; in other words, your vessel and crew may be put at risk.

**How you can improve with DNV GL**

Many of the findings are typical maintenance issues such as lights, shapes, sound signals, pilot ladder, and compass corrections. These are easily rectified by a review and implementation of the maintenance system, with improved procedures for documentation. An investment in the human factor, with focused campaigns to improve the most frequent findings, can result in a major improvement.

When it comes to ECDIS, the training of navigational officers, both generic and specific, is essential in the preparation for the implementation of this retroactive requirement. The SMS system should be updated to ensure that ECDIS operations are properly covered. It goes nearly without saying that approved and up-to-date ECDIS systems should be used to reflect new chart software.

Study by Swedish Club into navigational claims 2014: of the four main types of ships, bulk carriers have the highest frequency of grounding and associated costs.
MARPOL

The International Convention for the Prevention of Pollution from Ships, MARPOL aims to preserve sea life and the maritime environment by taking measures to eliminate pollution caused by harmful substances. Therefore, a number of requirements are stipulated that must be adhered to by all signatories to the convention.

Insights gained by DNV GL from industry observations
On the bulker fleet of DNV GL, most MARPOL-related findings are in regards to pollution by oil and garbage, but also sewage and air pollution have shown to be important factors.

PSC deficiencies of DNV GL bulk carriers (2011–2015)

Some of the main deficiencies are related to:
- Oil filtering and discharge monitoring equipment
- Standard sewage discharge connection
- Missing discharge rate table for untreated sewage
- Incorrect handling of garbage
- Incinerator and record book handling

Consequences of MARPOL-related detentions
A very high number of MARPOL deficiencies also lead to detentions. For example, the insufficient handling or breakdown of the sewage treatment plant can lead to the unintentional discharge of black water, which might lead to heavy fines. All vessels with a holding tank for untreated sewage are required to have a sewage discharge rate table on board. If they do not, this will be a deficiency. The result for the insufficient handling of the record book regarding air discharge might lead to a PSC deficiency.

How you can improve with DNV GL
To avoid PSC detentions and costly delays, the equipment needs to be calibrated on a regularly basis by a qualified manufacturer. Ensure the crew is trained sufficiently on how to handle the incinerator, how to operate the sewage treatment plant, etc.

By increasing awareness of the consequences of MARPOL deficiencies, you can sensitize the crew about this important topic.

Furthermore, establish suitable maintenance routines of all oil filtering equipment on board and ensure they are properly implemented. Maintain accurate records and logs, and train the crew in record-keeping, particularly regarding the Oil Record Book.
HOW YOU CAN IMPROVE ON PSC PERFORMANCE WITH DNV GL

The short overview on the previous pages only serves as an introduction to some of the most important learnings DNV GL has gained from this study. In addition, DNV GL’s individual customers will get more detailed and customized insight reports as part of our annual Company class and PSC benchmarking reporting. In these reports, we show detailed performance of the customers’ fleet with respect to PSC and class issues, along with benchmarking data for the average performance of all bulk carriers under DNV GL class.

Experience has shown that the majority of PSC deficiencies are either due to issues with record-keeping or document control, or inadequate day-to-day maintenance, which is closely linked to the human factor. Therefore, there are some steps you may take to improve the PSC performance:

1. Break down the individual elements and identify the frequency and consequences of deficiencies
2. Evaluate the safety management system covering these elements
3. Identify root cause, such as lack of guidance, lack of training or awareness, not following the system
4. Conduct training to increase awareness about the consequence of non-compliance and focus on same during the shipboard audits
5. Usually, many of the findings are typical maintenance issues
6. Review the planned maintenance system (PMS) and ensure the PMS is properly implemented
7. Improve the procedures for document control
8. Conduct focused campaigns to improve most frequent findings

To help owners ensure PSC compliance, DNV GL started from autumn 2015 to add one hour for the surveyor to inspect the Top 18 PSC detainable items, in addition to the normal survey scope of bulk carriers. The additional hour will not be invoiced to the customer, and the items have been included in the checklists for annual survey scopes as relevant. The DNV GL surveyors will check these items especially thoroughly during their annual surveys. These 18 items are based on both the frequency and consequence of PSC detentions.

<table>
<thead>
<tr>
<th>PSC - Top 18 detainable items</th>
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<tbody>
<tr>
<td>1. Fire dampers</td>
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<tr>
<td>2. Emergency source of power - emergency generator</td>
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<tr>
<td>3. Lifeboats</td>
</tr>
<tr>
<td>4. Rescue boats</td>
</tr>
<tr>
<td>5. Launching arrangements for survival craft</td>
</tr>
<tr>
<td>6. Fire detection</td>
</tr>
<tr>
<td>7. Fixed fire extinguishing installations</td>
</tr>
<tr>
<td>8. Oil filtering equipment</td>
</tr>
<tr>
<td>9. 15 PPM alarm arrangements</td>
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<tr>
<td>10. Fire doors/openings in fire-resisting divisions</td>
</tr>
<tr>
<td>11. Jacketed high-pressure lines and oil leakage alarm</td>
</tr>
<tr>
<td>12. Fire pumps and their pipes</td>
</tr>
<tr>
<td>13. Emergency fire pumps and their pipes</td>
</tr>
<tr>
<td>14. Hull damage impairing seaworthiness</td>
</tr>
<tr>
<td>15. Means of control (opening, pumps) in machinery spaces</td>
</tr>
<tr>
<td>16. Sewage treatment plant</td>
</tr>
<tr>
<td>17. Ventilators, air pipes and casings</td>
</tr>
<tr>
<td>18. Emergency lighting, batteries and switches</td>
</tr>
</tbody>
</table>
The DNV GL PSC Toolkit is a collection of useful tools created to support Masters and the crew in preparing for Port State Control (PSC) inspections and to help reduce the risk of detentions as well as to add to the ship’s safety. The DNV GL PSC Toolkit is intended to be a supplement to the vessel’s existing on-board Maintenance and Safety Management System.

The DNV GL PSC Toolkit consists of:

- A software called “PSC Guide Wizard” for generating checklists
- A user manual for the software showing how it can be customized
- A flowchart called “Master’s quick guide for PSC inspections”
- A handy booklet called “Port State Control Quick Guide”
- Awareness posters in the DIN A3 format showing “Good practice” and “Bad practice”
- A chapter with an introduction to Port State Control, including an overview of PSC regimes

A number of checklists have been developed to cover the most frequent detainable PSC items around the world. The software is designed to be as user-friendly as possible – allowing users to customize the content by modifying the checklist areas, add or delete tasks, replace or insert more pictures to make it specific to the ship or equipment.

DNV GL also provides support, information and training in PSC matters to prepare you for inspections – and are on your side at all times.

More information: dnvgl.com/psc
CLASS FINDINGS

About 4,300 Conditions of class (CC), Conditions of Authorities (CA) and non-conformities (NC), coming from around 33,000 periodical surveys, have been analysed. Some observations are:

- There is a slight negative trend in the overall maintenance level
- The number of CCs has increased in the last two years
- The number of postponed CCs has increased significantly
- Non-conformities reached a peak in 2013, and then reduced when focus was increased on risk management

Comparison with PSC findings
Although there are many similarities in what a class surveyor and a PSC inspector find, such as issues related to fire safety, life-saving equipment and navigational equipment, we also see clearly that the scope of work and the focus areas may differ. The most frequent class findings:

1. Hull-related findings in the ballast tanks
2. Hull findings in cargo holds, deck and side:
   - Corrosion
   - Contact damages
   - Cracks
3. ISM observations (“Vessel operations” in the graph)

Maintenance level
When a DNV GL surveyor carries out an annual survey, he will in addition to the class and statutory survey also do an assessment of the maintenance level observed in four areas: the deck, accommodation, safety equipment and engine room. If a surveyor reports poor maintenance in any of these categories, the technical manager will be informed and a dialogue will ensue.

For the bulk carrier fleet, a slightly negative trend in maintenance level has been seen. The average maintenance rating for bulk carriers was 10% lower in 2015 compared with 2012. There is relatively little variance between the four areas, but deck and safety equipment have the lowest score and accommodation the highest score.

Class Survey Findings Top 10

<table>
<thead>
<tr>
<th>Category</th>
<th>Class Survey Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bilge handling, ballasting and drainage</td>
<td>3,400</td>
</tr>
<tr>
<td>Cargo storing</td>
<td>3,300</td>
</tr>
<tr>
<td>Vessel operation</td>
<td>3,200</td>
</tr>
<tr>
<td>Life-saving equipment</td>
<td>3,100</td>
</tr>
<tr>
<td>Reference requirements</td>
<td>3,000</td>
</tr>
<tr>
<td>Watertight and weathertight integrity</td>
<td>2,900</td>
</tr>
<tr>
<td>Fire fighting</td>
<td>2,800</td>
</tr>
<tr>
<td>Structural strength - ship</td>
<td>2,700</td>
</tr>
<tr>
<td>Propulsion, conventional</td>
<td>2,600</td>
</tr>
<tr>
<td>Navigation</td>
<td>2,500</td>
</tr>
</tbody>
</table>

Average maintenance rating
There has also been a negative development regarding loss of anchor and chain. The costs for loss of anchor are increasing, and bulk carriers are also affected. Consequences due to salvage, replacement and PSC detentions are the result, and it may also have a severe impact on the safety - in worst case putting ship and crew at risk. From our data analysis, we recognize that there has been a distinct increase over the last years in the number of anchor chain and anchor losses on all ship types, including the bulk carrier fleet.

**Insights gained by DNV GL from industry observations**

A study into the root causes has revealed that a majority of these losses could be avoided by increased awareness of the environmental limitations for the anchoring equipment, more attention to some key technical issues and general good seamanship. Key technical observation are related to the D-shackle bolt coming loose due to a detached securing pin, uncontrolled release of the anchor chain due to excessive wear of the brake band linings, and brakes not adjusted properly.

We also see that about half of the losses appear to be related to operational issues, such as:

- staying at anchor in overly heavy weather,
- anchoring in waters too deep,
- not securing the anchor chain properly while at anchorage, and
- failure of the winch/motor.

DNV GL realizes both the safety aspect and the high costs associated with anchor losses, and has therefore based on these findings initiated a cooperation with P&I clubs Gard and Swedish Club to analyse the problem, risks and possible mitigations.

The P&I clubs confirm the same trend as shown by DNV GL class records: there has been a negative trend during both 2014 and 2015, with six to ten anchors lost for every 1,000th ship per year, for bulk carriers.

**How you can improve with DNV GL**

There are various measures which can be taken to prevent loss of anchor, many concerning operational issues. This is where the human factor comes in: knowing the critical parameters to control when dropping and heaving the anchor, making the right decisions during adverse weather, proper securing and undertaking inspection and maintenance measures.

Specific DNV GL services include:

- Newsletter to the industry together with Gard and Swedish Club
- Anchor loss awareness package for officer seminars, including a video, presentation with soundtrack and case studies available
- Focus on anchoring procedures during ISM audits, newbuilding and ship in operation surveys
- Information about maximum environmental loads in the Appendix to class
- Audits at selected manufacturers and yards

More information: [dnvgl.com/anchorloss](http://dnvgl.com/anchorloss)
This graph shows that there is a trend: the frequency of loss of anchor incidents has been increasing, and so has their cost, since 2012. Source: The Swedish Club

The average claim cost for loss of anchor, including deductibles, is in the order of USD 160,000. Source: The Swedish Club
INDENTS IN SHIP SIDE

From a structural strength point of view, the single skin ship side is the most critical element in a bulk carrier. Looking at the class findings and damages recorded for the ship side, deformation of side frames is the key challenge, while corrosion is the second most frequent observation. Deformed side frames and brackets typically due to:
- quay contact,
- tug operations, and
- ice damages.

Deformations of side frames reduce the load carrying capacity, and are therefore considered serious damage. If the crew themselves detect that side frames are deformed or tripped, class should be contacted immediately for evaluation.

Insights gained by DNV GL from industry observations
On the positive side, we now see a positive trend in the number of reported cracks. At the same time, we now see a positive trend in the number of reported cracks in the main frames. The increased strength standard introduced by IACS unified requirement No. S12, with continuous brackets in the upper and lower end, and is believed to have made a significant contribution to this reduced risk of cracking. As mentioned above, the combined cargo and ballast hold is more prone to fatigue cracks, and the connection between the corrugated bulkhead and the upper and lower stool as well as connection between lower stool and the inner bottom plate are the most typical crack locations.

The hatch coaming with its end brackets is another high-risk crack location, with a total of 163 findings of cracked and heavily damaged structure, and it’s a significant peak of findings in connection with the third renewal survey.

How you can improve with DNV GL
There are several design-related as well as operational measures that can be taken to reduce the risk of deformed side frames and brackets as well as corrosion:
- Consider additional reinforcement in way of tug contact points and beyond
- Reinforce a larger area in way of the tug contact points
- Maintain coating to avoid corrosion
- Train crew in frequent side frame inspections
BOILER DAMAGE

Whether due to corrosion, erosion, overheating, cracking or mechanical damage, boiler damage can have severe negative impact for the crew, the environment and the ship.

Insights gained by DNV GL from industry observations

Bulk carriers lag behind all other ship types when it comes to findings on boilers. However, the higher focus normally is not related to extra maintenance or equipment but to proper operation. Thus, if you increase the focus and operate your boilers carefully, the number of findings should be greatly reduced.

Some DNV GL findings include:

- Damages to oil-fired or exhaust gas heated steam boilers:
  - Creep and fatigue (40% of reported boiler damage)
  - Erosion and corrosion (30% of reported boiler damage)

- Deposits/sediments/fouling that reduce the heat transfer in the boiler, which reduces the flow rate

Consequences of boiler damage

Not only can boiler repairs be very expensive and time consuming, resulting in long downtimes, non-operability of a boiler may force you to use more costly marine diesel oil (MDO) for the further operation of your bulk carrier. For the operation of vessels burning heavy fuel oil (HFO), an especially high number of findings have been recorded in terms of the auxiliary boilers on bulk carriers.
How you can improve with DNV GL

Many measures which could be taken to prevent damage to boilers fall under maintenance. Here, too, the human factor plays a role in ensuring the appropriate attention to boilers is made by the crew on a regular basis.

Some issues to consider and measures that could be taken:

- Boiler water treatment is essential
- Check the quality of the boiler’s flame shape
- Start-stop intervals may be optimized
- Monitoring of oil-in-feed water must work
- Implement boiler monitoring notation (BMON)

The BMON class notation specially targets the container segment, in particular container ships with composite boilers, however the notation is also ideal for all ship types, including bulk carriers.

Class notation BMON

Reasons for BMON:

- Limit impact on the commercial operation of the vessel
- Increase awareness of boiler operation and maintenance
- Decrease the boiler deficiencies due to improved maintenance and follow-up, saving costs

Scope of BMON:

- New class notation established with technical and operational requirements
- Acceptance of Chief Engineer’s inspection of the steam/water side of the boiler at alternate boiler surveys
- Chief Engineer to present documentation to DNV GL, who will carry out the remaining scope of the survey

Improvements:

- Higher focus on boiler feed and condensate water management
- Improved monitoring of water quality
- Increased flexibility with regards to inspection of boiler internals

The number of auxiliary boiler damage situations found for bulk carriers is higher than for all other ship types, showing there is room here for improvement.
Crew training is key factor for increasing both safety and operational efficiency.

The common denominator for improving performance related to all areas described above is to ensure that the crew is properly trained and that regular maintenance procedures are in place. A deformation in the hull side, for instance, could be modest, but it's essential that the crew is trained in inspection and reporting of deformations of side frames, as this may severely affect the strength of the frames. Ensure that the areas for tug-reinforced areas are clearly marked and possibly consider expanding this area to prevent risk for contact damages and costly repairs.

AUXILIARY ENGINE DAMAGE

Due to the number and size of auxiliary engines installed, bulk carriers often struggle to comply with SOLAS requirements when one auxiliary engine fails, especially in older vessels. Temporary (rented) Containerized Generator Sets (CGS) often do not comply with the SOLAS requirements, and may therefore lead to both Condition of class (CC) or PSC detention, as well as impose an operational risk.

Insights gained by DNV GL from industry observations

Both DNV GL class findings as well as insurance companies see a trend towards a high frequency of damages on auxiliary engines, in particular on medium-speed engines.

Without compliance to SOLAS, the vessel is not allowed to sail, and upgrading a non-compliant temporary CGS to achieve compliance is often very time consuming and expensive.

How you can improve with DNV GL

As for all other equipment, it is also important for auxiliary engines to undergo proper maintenance, and to have a maintenance scheme which is properly adapted to the actual operation. The engine maker’s recommendations should be used as a basis – there is a high frequency of damages occurring shortly after maintenance by the crew, indicating that the maker’s recommendation has not been adhered to, for example by applying wrong assembly or torque tightening.

HOW YOU CAN IMPROVE ON CLASS PERFORMANCE WITH DNV GL

Crew training is key factor for increasing both safety and operational efficiency.

The common denominator for improving performance related to all areas described above is to ensure that the crew is properly trained and that regular maintenance procedures are in place.

A deformation in the hull side, for instance, could be modest, but it’s essential that the crew is trained in inspection and reporting of deformations of side frames, as this may severely affect the strength of the frames. Ensure that the areas for tug-reinforced areas are clearly marked and possibly consider expanding this area to prevent risk for contact damages and costly repairs.

Most of the maintenance deficiencies are related to issues with equipment that needs regular maintenance and testing. Most companies have established maintenance systems, but the challenge remains to implement this in day-to-day operations. Review the planned maintenance system (PMS) and implement it.

By focusing on the human factor and leveraging targeted campaigns to improve the most frequent findings, shipowners can keep costs low and avoid downtimes.
## SAFETY AWARENESS

### CARGO LIQUEFACTION

In addition to the insights we have shared on PSC and class findings on the previous pages, we also thought that a report on operational experiences would not be complete unless the number one safety issue for bulk carriers was also addressed, namely that of cargo liquefaction. During the last six years, more than a hundred seafarers have lost their lives on vessels carrying cargo that may liquefy, mostly from southern Asian ports. The vessels have capsized and sunk; the cause of the casualties has been attributed to cargo liquefaction and loss of stability. The vessels have been smaller vessels, with traditional bulk carrier cross-sections. Some of the vessels had only been in service for a few years, so poor condition has not been the issue.

The details of cargo liquefaction

Cargo liquefaction occurs for both granular and non-granular materials:

There are two prerequisites for liquefaction of granular materials such as iron ore fines and bauxite to occur. First, you need a cargo material with at least some fine particles. Second, you need a minimum moisture level. Liquefaction problems involving granular materials are most likely to occur shortly after loading. Usually, only parts of the cargo will be liquefied at the same time, leading in most cases to partial liquefaction.

Cargo liquefaction of non-granular materials such as some nickel ores is triggered by fatigue of the material. Liquefaction problems are most likely to occur several days or weeks after loading, and may happen for all the cargo on board simultaneously. It is also very difficult to stabilize the cargo after liquefaction.

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### Consequences of cargo liquefaction on stability

Cargo liquefaction leads to a free surface effect and/or cargo shift effect that influences the ship’s stability adversely. Studies have shown that the stability consequences may be largest for ships with full-width holds from side to side, in other words the typical bulk carrier configuration. For vessels with a more narrow cargo hold, such as ore carriers, stability will usually not become an issue. However, they may instead suffer structural damages due to a significantly higher pressure acting on the vertical structures.

### Consequences of cargo liquefaction on strength

Depending on the degree of liquefaction and the vessel's design and reserve structural capacity, the stresses from a liquefied cargo might exceed the allowable limits and the structure might suffer from permanent deformations. In worst case, this could lead to structural failure.

Our studies have shown that the structural consequences may be largest for ships that are highly optimized for the carriage of (dry) iron ore, while the consequences might be smaller or eliminated for ships that are designed for a wide variety of cargoes, since the amount of heavy iron ore that may be carried in each cargo hold on such ships is generally small.

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**Granular materials such as iron ore fines, iron concentrates, sinter feed or bauxite are normally the result of cargo compaction and increased pore water pressure.**

**The effect of cargo liquefaction on the hull wall (left) compared to the effect of cargo sliding against the hull wall (right).**
How you can improve with DNV GL

Although there are vessel design options that reduce the risks of cargo liquefaction, the main improvements are operational. DNV GL has therefore developed a guideline which describes such operational recommendations. Some of these recommendations include:

1. In case of unprocessed ore cargoes, for example iron ore fines, bauxite or nickel ore, it is critical that the correct transportable moisture limit (TML) and the moisture content (MC) are determined before loading commences. It is recommended to appoint an independent surveyor or cargo specialist for advice and to perform proper tests to verify the moisture content.

2. The metacentric height (GM) of the vessel should be carefully considered when carrying cargoes that may liquefy. If the loading condition and the structural strength of vessel allow it, the centre of gravity of the vessel could be raised by ballasting the top wing tanks or by loading the cargo in a non-homogeneous pattern. An excessive GM value results in shorter rolling periods and higher accelerations, which may trigger liquefaction. Furthermore, weather routing is recommended in order to avoid extensive motions.

3. Trimming the cargo is a well-known method for reducing the risk of cargo shift or cargo sliding. In addition, the stability and the weight distribution are improved. However, trimming increases the required time and cost for loading. Therefore, as a general recommendation, when carrying cargoes that may slide, the cargoes should be trimmed as necessary to ensure that they are reasonably level.

The DNV GL guideline contains both more detailed background of cargo liquefaction as well as design and operation recommendations on how to reduce the risks of cargo liquefaction.

Simply download it here: www.dnvgl.com/publications
DNV GL SERVICES TO THE BULK CARRIER INDUSTRY

ADDITIONAL SERVICES

To prepare for the next PSC inspection, or to simply be there when you need us most, rely on DNV GL as your partner at anytime and anywhere in the world. As the world’s largest classification society, we are able to conduct extensive research and constant analysis to evaluate the lessons learned from bulk carrier detentions and to provide competent answers to all your questions.

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PSC Interactive Workshop to support operators in achieving compliance

This one-day workshop offers practical guidance on how to prepare for and manage PSC inspections. Participants will be introduced to a number of useful PSC tools specially developed by DNV GL, and active participation in the workshop is stimulated through the study of actual cases.

The course focuses on:
- History, objectives and scope of PSC
- PSC regimes and targeting methods
- Inspection intervals and priorities
- On-board procedures
- Frequent findings and grounds for detention
- Reducing the risk of detention
- How to handle detentions and appeals
- Safety culture and the role of class
### Technology & Innovation

The need for developing new solutions is accelerating - whether to make the vessel more efficient, meet environmental regulations or reduce technical vulnerability.

DNV GL offers recognized procedures for qualifying technology, and we assist in bringing new solutions efficiently, safely and credibly to the market. We also support owners and yards exploring alternatives for innovation, in addition to supporting owners with expertise solving technical challenges.

### People & Competence

Competence and capabilities of crews are a constant challenge for the maritime industry.

DNV GL has developed best practice approaches for competence management, and supports shipping companies in improving their capabilities for both on-board and shipboard employees. In addition, DNV GL supports the industry with verifying and certifying training providers, simulators and courses.

### Environmental Excellence

The development of new and stricter environmental regulations is accelerating. DNV GL works with customers to both establish strategies and to implement actions to meet the environmental challenges in an efficient way.

### Complex IT Systems

The IT systems are becoming more and more sophisticated. DNV GL supports the industry in identifying risk, both with systems and the interfaces, to improve the system architecture and the robustness of the systems.

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About DNV GL
Driven by its purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance safety, quality, energy efficiency and environmental performance of the shipping industry – across all vessel types and offshore structures. We invest heavily in research and development to find solutions, together with the industry, that address strategic, operational or regulatory challenges.

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