Section I

GENERAL PROVISIONS ON THE ORGANIZATION OF CARRIAGE OF GOODS

Topic 3. Planning and routing of international transportation. Transportation technology

1. Delivering value in the shipping and receiving business process (GS1 System of Standards)
2. Delivering value in the warehouse management business process
3. Delivering value in the transport management business process
4. Transportation technology

1. Delivering value in the shipping and receiving business process (GS1 System of Standards**)**

Transport & Logistics (T&L) industry and its players form the backbone of global supply chains. Transport & Logistics processes in the supply chain provide critical links in the global economy, connecting the supply chains of countless retailers and manufacturers, serving many different industries in many different countries.

As goods move from points of origin to points of sale, logistics services providers (LSPs), freight transporters and their customers need to know precisely where shipments are at all times to make informed business decisions.

The use of GS1 Standards and solutions by supply chain stakeholders facilitates interoperability between systems and processes for enhanced supply chain visibility, security and sustainability. Further, it results in increased efficiencies in shipping and receiving as well as better warehouse, transport and asset management.

This is why progress has been made over several years to develop the GS1 System of Standards to better support the T&L industry. GS1 is now placing particular emphasis on supporting the drive towards adoption and implementation through various initiatives.

GS1 Standards provide unique identification of items and products that provide the link between the item and the information pertaining to it. Think of GS1 Standards as the DNA of an item or product moving through the supply chain.

It all starts with the GS1 Company Prefix. The GS1 Company Prefix is at the heart of the GS1 System of identifiers. It forms the base for a family of identifiers that are globally unique and can be used for a host of different applications. It may be a little string of numbers, but it's a huge investment in the future of the business.

GS1 Company Prefixes vary in length between seven digits and eleven digits – Different length prefixes provide you with different capacities for particular types of identifiers. Below is an example of the impact of different length GS1 Company Prefixes on the capacity, or number of GTINs, that can be assigned from a single prefix

GS1 Company Prefix Length	Enabled (Capacity)
Seven Digits (**0**NNNNNN)	100,000
Eight Digits (**0**NNNNNNN)	10,000
Nine Digits (**0**NNNNNNNN)	1,000
Ten Digits (**0**NNNNNNNNN)	100
Eleven Digits (**0**NNNNNNNNNN)	10

Let's say your company licenses a GS1 Company Prefix that allows you to build 100 GTINs (or, 100 different types of products that your company offers for sale). There is so much more that this little string of numbers can let you identify. What can you do with that same Company Prefix?

Identifiers	Capacity
GTIN (Global Trade Item Number)	100 types of products you sell
GLN (Global Location Number)	100 physical locations
GRAI (Global Returnable Asset Identifier)	100 types of returnable assets
GDTI(Global Document Type Identifier)	100 types of documents
SSCC (Serial Shipping Container Code)	1,000,000 shipments of goods
GSRN (Global Service Relationship Number)	10,000,000 service relationships
GIAI (Global Individual Asset Identifier)	10^20 (that's a Sextillion!) individual assets

That's a lot of power at the ready for inventory, accounting, order fulfillment, service agreements and asset management, to name just a of few business processes that benefit from clear and globally unique identifiers!

Pre-Announced Deliveries

For delivery notifications (DESADV), invoices (INVOIC) and other logistical transactions, the companies chose EDI-based transactions with GS1 Standards. Before the delivery of a shipment, consignee is notified via an electronically transmitted Despatch Advice containing the logistics unit's data elements: the SSCC, GTINs and number of cartons on each pallet.

This pattern of a Logistics Label demanded by consignee contains a barcode encoded with the SSCC and GTIN of a singular type of product loaded on the pallet.

The label shows the cartons of the product with the batch/lot number and best-before date.

For quick and accurate scanning, multiple copies of the transport label are placed on cartons based on GS1-recommended practices. GS1 technical support specialists should provide the needed expertise and assistance during the implementation of GS1 Standards on the labels as well as in EDI transaction documents.

To emphasize the importance of successful use of the established norms of GS1 System of Standards we can cite as an example Frode Laursen and Toms Chocolate Factory's smooth operation of Third-Party storage facility.

About Toms: The Toms Group has 725 employees in Denmark and Sweden. Most of the staff work at the headquarters in Ballerup, which is Denmark's largest chocolate factory. Toms' Management Board includes Jesper Miller, CEO, who is also chairman of the Danish Confederation of Industries, and Anders Hagh, CFO.

About Frode Laursen: Frode Laursen is a leading Nordic provider of logistics solutions for the daily commodities market and the construction sector. Frode Laursen has 1,400 employees and a storage capacity of 330,000 mI. Frode Laursen is owned by Thorkil Andersen.

With a high volume of sweets and need for storage capacity, Toms Chocolate Factory (Toms) called on a transport and logistics partner, Frode Laursen, to provide a more efficient, common storage facility for all its business units. To facilitate this outsourcing arrangement, the company needed a way to jointly manage its inventory.

Toms decided to digitise its inventory management using GS1 Standards and Electronic Data Interchange (EDI) technology. Each pallet traveling from Toms' facilities to storage is labeled with a GS1-128 label, containing information such as the number of crates on the pallet, best-before data and batch number. The labels are scanned each step of the way for visibility of goods as they travel to the warehouse and then, on to customer locations. Customers place their orders electronically, automatically notifying Frode Laursen to pick and deliver the orders while Toms invoices customers.

Approximately 85% of products received by Frode Laursen are labeled with the GS1-128 label, leading to

increased visibility as they travel along the supply chain. Improved customer service and satisfaction since Toms can provide them with status on order deliveries. Increased efficiencies of in warehouse management based on available logistics information.

Outsourcing to Third-Party Storage Facility

Toms Chocolate Factory in Ballerup, Denmark, produces 16,000 tonnes of chocolate a year, mainly destined for the Danish market. An additional 10,000 tonnes of sugar confectionery are produced at Toms' factory in Avedre Holme, also in Denmark. And yet another 4,000 tonnes of sugar confectionery are made at the Habo factory near Jonkoping, Sweden. This impressive volume of sweet goods means that Toms has a huge demand for storage capacity, and this demand has increased significantly over the years. To improve its efficiency, Toms wanted a common storage facility for all its business units, but none of its three factories had sufficient space. The solution: find an external partner.

To facilitate outsourcing of storage needs, pertners required a way to jointly manage things. They chose to digitise the entire storage logistics, and based their

integration on the GS1 EDI standard and the GS1-128 pallet label. Everything was done by means of electronic transactions. Of course, it's a matter of trust and requires to maintain a complete overview of the stock at any time so partners can trace a delivery no matter where it is in the system."

GS1 Standards for a Smooth Supply Chain

Since 2005, transport and distribution operator Frode Laursen has arranged for the transportation of all of Toms' sweet products to customers throughout Denmark and in parts of Sweden. Frode Laursen's drivers transport some 120,000–130,000 pallets from Tom's three factories to the storage facility every year. Everything runs smoothly, requiring only a minimum of resources on the parts. Partners have developed a system and a logistics operation that work, meaning that they have the same contact with the storage management as if it were an internal operation.

Both Frode Laursen and Toms have acquired vast experience with GS1 EDI and the GS1-128 pallet label which is central to all the information required for transporting the products to the customer's doorstep.

Keeping Track of the Product at All Times

After packaging a pallet of chocolate at Toms' production facilities, a GS1-128 pallet label is affixed to the pallet, containing information such as the number of crates on the pallet, best-before date and batch number. The fork-lift terminals are then automatically notified and a fork-lift truck is sent to pick up the pallet. When the fork-lift driver scans the label on the pallet, it tells him whether to take it to the shunting area or storage. When a truck from Frode Laursen arrives, each pallet is re-scanned to ensure that the agreed number of pallets is loaded. The product status at Tom now changes from in-house to being in the care of Frode Laursen. At the same time, an electronic message is sent to inform Frode Laursen that the goods are in transit. This gives both Toms and Frode Laursen a complete up-to-date picture of the process and allows them to follow the product and see who is responsible for it at any time – exclusively facilitated by scanning and electronic data sharing.

High-Quality Labeling Throughout the Supply Chain

Pallets are scanned on arrival to Frode Laursen's storage facility. All pallet content information into Laursen's system. Then they send electronic data back to Toms to let them know the products are now at Laursen's storage facility. This gives Toms a complete up-to-date overview of which products they can sell, even though the external storage facility.

One reason for the robust and efficient partnership between Toms and Frode Laursen is that Frode Laursen has great knowhow and experience in the use of GS1 Standards. They use the GS1-128 label for all our customers (some 85% of the products) because using the GS1 Standard guarantees swift, readable information to ensure high-quality, transparent goods delivery. And the same label is used when the product is forwarded to the customers. If the company receives products with a different type of label, it sets up a GS1 label and affix this instead. This enables the company to assure the quality of deliveries. They also give feedback to customers and suppliers if their labelling fails to comply with the GS1 Standard. In this way, knowledge and use of the system is increased to the benefit of all.

Foundation for Superior Customer Service

The last stage from storage to customer is also supported by digital information. As soon as Frode Laursen receives an order from the customers, the company is automatically notified of when to deliver the order. Frode Laursen handles order-picking and delivery. After delivery, Toms is notified.

Cosmetics manufacturers and retailers also take common logistics approach with gs1 standards.

Due to its global reach, the cosmetics sector in France is especially concerned about consumer safety and has strict requirements when selling products around the world. When European regulation related to cosmetics required that manufacturers and retailers establish traceability and recall processes, the industry organised for a common approach in logistics operations.

Manufacturers and retailers created common logistics processes, common transaction messages and a common data model using a wide array of GS1 Standards. Today, 85% of participating companies are using GS1 Standards for identification and

traceability. As a result, withdrawals are swift with cosmetics companies executing a withdrawal in a matter of a few hours for greater consumer safety. Furthermore, significant efficiencies have been realised with GS1 Standards-powered logistics processes.

Benefits:

- Compliance with European cosmetic sector regulation.
- Achieved traceability for fast withdrawals.
- Improved productivity with accurate, faster transactions.
- Increased consumer safety and confidence.

Regulatory Requirements

The French luxury cosmetic sector needed to comply with European regulation related to cosmetics (1223/2009/EU), which was effective July 2013. The regulation requires that every manufacturer and retailer in the cosmetic sector, working with its trading partners, ensure consumer safety by establishing traceability capabilities for all products along the supply chain. Another mandate of the regulation requires trading partners to adopt a withdrawal process in the event of product safety non-compliance.

With support from the national federations for retailers and suppliers, a main goal was set for the entire sector: to adopt the same logistics standards that would support the new legal requirements as well as modernise the supply chain.

In addition, objectives were established to create common logistics best practices for consumer units and cartons, common messages for transactions like orders and invoices, and a common data model for items.

Common Approach

GS1 France and ECR France partnered to host all working groups (requested by the sector) during a five-year work effort. This mobilisation of so many retailers and manufacturers was unprecedented in the French cosmetics sector.

In 2011, manufacturers and retailers of select cosmetics companies started their conversion to GS1 Standards.

Continued work is planned until 2015 to achieve an even more advanced supply chain than the fast-moving consumer goods (FMCG) sector. A total of 29 solution providers are supporting the effort.

For each workflow step, the following GS1 Standards were adopted:

• The Global Trade Item Number® (GTIN®), Serial Shipping Container Code (SSCC), and GS1-128 barcodes to enable common logistics best practices for consumer units and cartons.

EANCOM® messages, ORDERS (orders), DESADV (Despatch Advise), INVOIC (invoices) and REMADV (Remittance Advise) to enable common transaction messages.

• Global Data Synchronisation Network™ (GDSN®) attributes, Global Product Classification (GPC) attributes, GS1 eXtensible Markup Language (XML), and GS1-documented Product Image Specifications to enable a common data model for items. In the French market, these players in the cosmetics sector will be first to massively adopt GS1 Product Image Specifications (before the FMCG sector).

Successful Compliance

Today, 85% of the sector's participating companies are using GS1 Standards for identification like the GTIN and SSCC. And they are also now compliant with the European regulation for cosmetics regarding traceability and the withdrawal process, thanks to GS1 Standards.

Using GTINs, SSCCs and EDI messages, cosmetics trading partners can execute a withdrawal worldwide in a matter of a few hours, greatly enhancing consumer safety. And by using EDI transactions, these companies avoid tedious, manual data entry and re-entry, thus, freeing up time for their employees to dedicate to other pressing activities.

During the work effort, companies collaborated to meet these challenges, including:

• Defining a common and approved global work cycle in cooperation with all players.

• Enrolling companies not using GS1 Standards in the working groups.

• Ensuring neutrality and parity between manufacturers and retailers to guarantee final adoption, especially by small and medium-sized enterprises.

• Adapting GS1 Standards and processes for luxury items based on their own unique attributes: high-value, slow-moving consumer goods, and stringent security requirements all along the supply chain.

Success Factors

The cosmetics sector attributes its success to several factors:

• Players reached an initial agreement concerning goal and objectives.

• Players understood the benefits of cooperation and of using neutral, open and international standards.

• Communication among players was facilitated by neutral organisations, ECR France and GS1 France that offered working groups and open meetings to every company in the sector.

• Players decided to adopt already tried-and-tested standards and processes from the FMCG sector.

Due to their success, the manufacturers and retailers plan to expand the use of GS1 Standards throughout Europe with help from GS1.

To this end, GS1 in Europe welcomes interested retailers and manufacturers in the cosmetics sector to support the European harmonisation of standards and processes.

2. Delivering value in the warehouse management business process

To optimise supply chain operations, the transport and logistics industry wanted to issue more electronic invoices and transfer them via EDI (electronic data interchange) procedures between trading partners.

Formed from the ECR Austria Service Platform “EDI Profile” and the Logistics Network Mehrweg (LMW) Initiative, a working group developed message formats for three types of invoices: forwarding invoice, warehouse invoice and pro-forma invoice.

Benefits:

• Reduced transaction and communication costs.

• Lower administration costs.

• Reduced errors for lower quality and error-correction costs.

• Improved information base for optimising logistics processes.

• Longer-term partnerships and closer cooperation between trading partners.

In April 2013, the sub-working group of the ECR Austria service platform, "EDI Profile," was launched to define a national invoice standard for freight forwarding and warehouse billing (INVOIC). The working group agreed that the information standard should build on the current EDI-message format, EANCOM®.

During the past decade, all necessary logistics messages between industry players, logistics services providers (LSPs), and transport carriers were defined as part of the ECR logistics information flow. The final process of logistics billing between trading partners was, however, not specified.

Therefore, in the summer of 2013, the working group was revived to address this need. As a result, it defined an INVOIC standard for forwarding and warehouse billing.

In light of the current Value Added Tax (VAT) legislation and the associated facilitation of electronic invoices, the message-type INVOIC has been, therefore, defined as an industry standard between LSPs, suppliers and retailers. This enables automated invoice data management and coverage of logistics services through Global Trade Item Numbers (GTINs).

Cooperative Approach

The reason for re-establishing the working group came from suppliers and retailers that expressed the desire for more electronic invoices as well as the ability to transfer them via EDI procedures for improved supply chain processes.

For improved collaboration, companies representing industry and trade from the existing ECR Austria Service Platform "EDI Profile" also invited forwarding and freight companies of the Logistics Network Mehrweg (LMW) Initiative to take part in the working group. All participating companies exclusively consist of members of the ECR Austria initiative. This was greatly appreciated by all participating companies since synergies between GS1, ECR and LMW could be fully leveraged and exploited.

Anticipated benefits from the introduction of electronic invoices in logistics processes include:

• Reduced transaction and communication costs through bundling, standardisation and automation of information processes.

• Lower administration costs by ensuring the complete information is provided in a timely manner without any media disruption.

• Minimized quality and error-correction costs through up-to-date transparency in the physical flow of goods such as shipment tracking, freight tracking, and more.

• Reduced errors by eliminating manual data-collection processes.

• Improved information base for optimising logistics processes; for example, inventory reduction, customs clearance acceleration, and improved presence through higher product availability.

• More long-term partnerships and closer cooperation between the trading partners in the supply chain.

After only three meetings, the working group quickly created a concept and content model for the logistics invoice. Two message formats were defined: a commercial invoice and a consolidated invoice. The syntactic structure of messages − EANCOM® message INVOIC = invoice − was adapted for the existing message definition based on the electronic invoice from the consumer goods industry and extends only to some fields determined by the group.

Invoice Types

The specified invoice types are the forwarding invoice, warehouse invoice, and pro-forma invoice.

The forwarding invoice includes the physical transport of one or more shipments from the delivery point to the receiving point. For example, this can be a ramp from the goods shipper, consignee of the goods, and LSPs. A forwarding invoice or credit note can be created between the shipper of the goods and the LSP, as well as between LSPs and the actual carrier or service provider.

The warehouse invoice includes warehouse services invoiced in various forms, such as a value-added service (VAS). It shall be established as a rule between the consignor of the goods and a LSP that is responsible for the warehousing of goods shipped.

The pro-forma invoice is required as a proof-of-order or delivery for the transacted deliveries and logistics services. It is the preliminary information for either the invoice recipient or for any other partner involved in the logistics process. This type of invoice is used primarily for transparency and automation of the process, and is typically in-use only for a certain period of time. It should be noted that the pro-forma invoice has no payment character, and thus, does not trigger a payment by the receiving company.

3. Delivering value in the transport management business process

Transport Management Using GS1 Standards in a SME Project

Partners Involved

PROZEUS provides clear information on eBusiness standards to help small and medium-sized companies (SME) acquire eBusiness competence. ***[www.prozeus.de]***

Spedition Martin was established in 1975. They focus on procurement and distribution logistics, especially in the areas of Fast Moving Consumer Goods and General Industrial Goods

Germany-based Spedition Martin and its French trading partner, GCF, participated in the PROZEUS project to achieve standardised, paperless execution of invoices and transport instructions in a cross-border deployment. They aimed to accelerate their communication processes for significant cost and time savings as well as avoid loading and accounting errors.

For the successful implementation of cross-border electronic data transfer, the companies use Electronic

Data Interchange (EDI) along with GS1 EANCOM® recommendations. The GS1 Electronic Transport Instruction (IFTMIN) is being used from GCF to Spedition Martin, and the electronic invoice (INVOIC) is used from Spedition Martin to GCF.

Benefits:

• For Spedition Martin, improved competitiveness and stronger customer relations, helping to win more customers.

• Payback period of 1.6 years with an annual savings of € 13,200 based on time savings for transport instruction and billing creation.

• Accelerated communication between trading partners

• Eliminated need for manual data entry.

• Avoidance of accounting errors and incorrect shipments

Need for Standardisation

The PROZEUS project was jointly carried out by GS1 Germany and IW Consult, with the support of the German Federal Ministry of Commerce & Technology. The aim of the project was to achieve a paperless execution of invoices and transport instructions in a cross border deployment with Germany and France. To execute the project, SMEs (Small and medium-sized enterprises) were selected to test within their own operations German Spedition Martin and their French trading partner GCF participated by testing eBusiness solutions based on globally applicable processes and standards. Partnered for many years, the two companies have already identified the potential of standardised cross-company processes for the entire value chain.

The first step of the project was to determine an efficient process for the electronic transmission of invoices and transport instructions. By switching to the Electronic Data Interchange (EDI), the companies aimed to accelerate their communication processes and to achieve significant cost and time savings. In addition, they wanted to avoid loading and accounting errors by establishing standardised international processes.

Essential for the successful implementation of cross border electronic data transfer was the creation of appropriate structures within the companies and their participation in the global GS1 System.

In order to monitor and steer the project's progress, including the necessary technical changes, a detailed timetable was drawn up which was regularly checked and adjusted.

Another important step was to define the interfaces. The formulation helped the EDI Clearing Centre in the implementation of technical aspects and created higher transparency regarding data sources and integrity.

Critical Success Factors

• Definition of EDI-interfaces.

• Organisational adjustments.

• Cross functional project.

• Dedicated project leadership.

• Analysis of the as-is-state.

• Definition of the target-state.

Key Learnings

• Project management is an essential factor in the planning, implementation and control of a cross-border EDI-introduction.

• Cooperation, accurate planning, management and documentation of activities are all crucial.

• Test phases and the rapid implementation of corrections were also important criteria for success.

Significant Results Achieved

Spedition Martin was able to strengthen and expand their competitiveness. Customer satisfaction improved, strengthening their existing business relations and helping them to win new customers.

An economic analysis showed that investment costs of Spedition Martin would already be paid back in the second year if two other EDI-partners could be found, which was the case.

The cost savings from the introduction of electronic message IFTMIN (70%of savings) and through the introduction of cross-border INVOIC accounts (30% of savings) come from time savings:

• 80 min. per day saved in terms of transport instruction creation (for GCF and 2 other partners).

• Daily time savings during billing (5 minutes/day to GCF and 15 minutes/day to other business partners).

GS1 Standards Used

Based on the GS1 EANCOM ® recommendations, the following GS1 standards were implemented:

• Electronic Transport Instruction (IFTMIN): transport assignment from GCF to Spedition Martin in Germany.

• An electronic invoice (INVOIC) from Spedition Martin to GCF in France.

4. Transportation technology

Bulk carrier's transportation technology

Crew

The crew on a bulker typically consists of 20 to 30 people, though smaller ships can be handled by 8. The crew includes the captain or master, the deck department, the engineering department, and the steward's department. The practice of taking passengers aboard cargo ships, once almost universal, is very rare today and almost non-existent on bulkers.

During the 1990s, bulkers were involved in an alarming number of shipwrecks. This led ship-owners to commission a study seeking to explain the effect of various factors on the crew's effectiveness and competence. The study showed that crew performance aboard bulk carriers was the lowest of all groups studied. Among bulker crews, the best performance was found aboard younger and larger ships. Crews on better-maintained ships performed better, as did crews on ships where fewer languages were spoken.

Fewer deck officers are employed on bulkers than on similarly sized ships of other types. A mini-bulker carries two to three deck officers, while larger Handysize and Capesize bulkers carry four. Liquid natural gas tankers of the same size have an additional deck officer and unlicensed mariner.

Voyages

A bulker's voyages are determined by market forces; routes and cargoes often vary. A ship may engage in the grain trade during the harvest season and later move on to carry other cargoes or work on a different route. Aboard a coastal carrier in the tramp trade, the crew will often not know the next port of call until the cargo is fully loaded.

Because bulk cargo is so difficult to discharge, bulkers spend more time in port than other ships. A study of mini-bulkers found that it takes, on average, twice as much

time to unload a ship as it does to load it. A mini-bulker spends 55 hours at a time in port, compared to 35 hours for a lumber carrier of similar size. This time in port increases to 74 hours for Handymax and 120 hours for Panamax vessels. Compared with the 12-hour turnarounds common for container ships, 15-hour turnarounds for car carriers, and 26-hour turnarounds for large tankers, bulker crews have more opportunities to spend time ashore.

Loading and unloading

Loading and unloading a bulker is time-consuming and dangerous. The process is planned by the ship's chief mate under the direct and continued supervision of ship's captain. International regulations require that the captain and terminal master agree on a detailed plan before operations begin. Deck officers and stevedores oversee the operations. Occasionally loading errors are made that cause a ship to capsize or break in half at the pier.

The loading method used depends on both the cargo and the equipment available on the ship and on the dock. In the least advanced ports, cargo can be loaded with shovels or bags poured from the hatch cover. This system is being replaced with faster, less labor-intensive methods. Double-articulation cranes, which can load at a rate of 1,000 tons per hour, represent a widely used method, and the use of shore-based gantry cranes, reaching 2,000 tons per hour, is growing. A crane's discharge rate is limited by the bucket's capacity (from 6 to 40 tons) and by the speed at which the crane can take a load, deposit it at the terminal, and to return to take the next. For modern gantry cranes, the total time of the grab-deposit-return cycle is about 50 seconds.

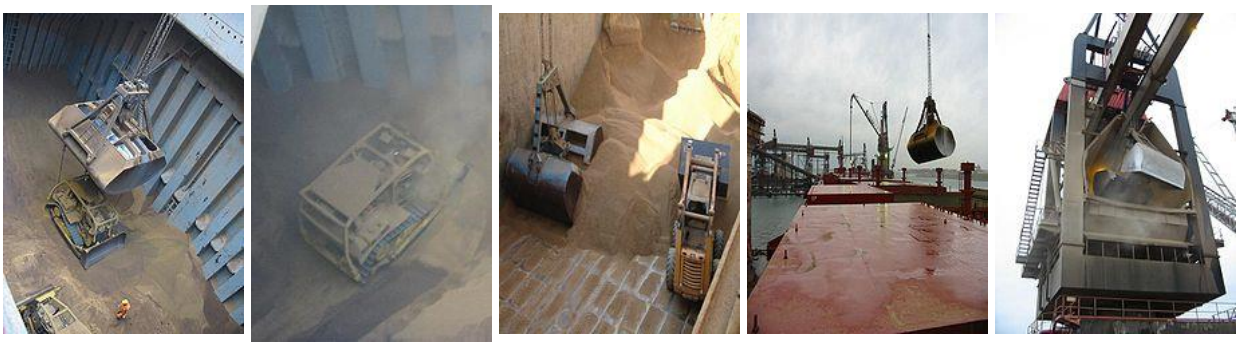
Conveyor belts offer a very efficient method of loading, with standard loading rates varying between 100 and 700 tons per hour, although the most advanced ports can offer rates of 16,000 tons per hour. Start-up and shutdown procedures with conveyor belts, though, are complicated and require time to carry out. Self-discharging ships use conveyor belts with load rates of around 1,000 tons per hour.

Once the cargo is discharged, the crew begins to clean the holds. This is particularly important if the next cargo is of a different type. The immense size of cargo

holds and the tendency of cargoes to be physically irritating add to the difficulty of cleaning the holds. When the holds are clean, the process of loading begins.

It is crucial to keep the cargo level during loading in order to maintain stability. As the hold is filled, machines such as excavators and bulldozers are often used to keep the cargo in check. Leveling is particularly important when the hold is only partly full, since cargo is more likely to shift. Extra precautions are taken, such as adding longitudinal divisions and securing wood atop the cargo. If a hold is full, a technique called tomming is used, which involves digging out a 6 feet (2 m) hole below the hatch cover and filling it with bagged cargo or weights.

A typical bulker offload

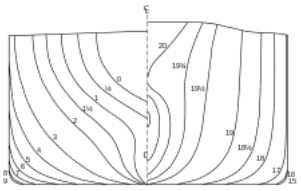


1. A bulldozer is loaded into the hold. **2.** The bulldozer pushes cargo to the center of the hold. **3.** The gantry crane picks up the cargo. **4.** The gantry crane removes the cargo from the ship. **5.** The gantry crane moves the cargo to a bin on the pier.

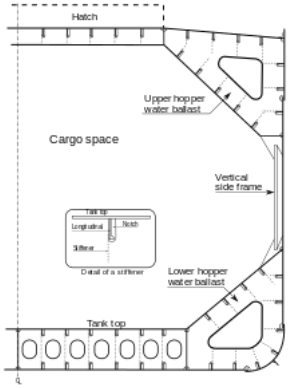
Photos courtesy of Danny Cornelissen of portpictures.nl.

Architecture

Examples of bulker architectural plans



Line plan of a 1990 Capesize ore carrier.



Typical midship section of a bulker with a single hull and double bottom.

A bulk carrier's design is largely defined by the cargo it will carry. The cargo's density, also known as its stowage factor, is the key factor. Densities for common bulk cargoes vary from 0.6 tons per cubic meter for light grains to 3 tons per cubic meter for iron ore.

The overall cargo weight is the limiting factor in the design of an ore carrier, since the cargo is so dense. Coal carriers, on the other hand, are limited by overall volume, since most bulkers can be completely filled with coal before reaching their maximum draft.

For a given tonnage, the second factor which governs the ship's dimensions is the size of the ports and waterways it will travel to. For example, a vessel that will pass the Panama Canal will be limited in its beam and draft. For most designs, the ratio of length-to-width ranges between 5 and 7, with an average of 6.2. The ratio of length-to-height will be between 11 and 12.

Machinery

The engine room on a bulker is usually near the stern, under the superstructure. Larger bulkers, from Handymax up, usually have a single two-stroke low-speed crosshead diesel engine directly coupled to a fixed-pitch propeller. Electricity is produced by auxiliary generators and/or an alternator coupled to the propeller shaft. On the smaller bulkers, one or two four-stroke diesels are used to turn either a fixed or controllable-pitch propeller via a reduction gearbox, which may also incorporate an output for an alternator. The average design ship speed for bulkers of Handysize and above is 13.5–15 knots (25.0–27.8 km/h; 15.5–17.3 mph). The propeller speed is relatively low, at about 90 revolutions per minute, although it depends on the size of the propeller.

As a result of the 1973 oil crisis, the 1979 energy crisis, and the resulting rise in oil prices, experimental designs using coal to fuel ships were tested in the late 1970s and early 1980s. The Australian National Lines (ANL) constructed two 74,700-ton coal-burner ships called the *River Boyne* and *River Embely*. along with two constructed by TNT called *TNT Capricornia* and *TNT Capentaria* and renamed *Fitzroy River* and

Endeavor River. These ships were financially effective for the duration of their lives, and their steam engines were able to generate a shaft-power of 19,000 horsepower (14,000 kW). This strategy gave an interesting advantage to carriers of bauxite and similar fuel cargoes, but suffered from poor engine yield compared to higher maintenance cost and efficient modern diesels, maintenance problems due to the supply of ungraded coal, and high initial costs.

Hatches

A hatch or hatchway is the opening at the top of a cargo hold. The mechanical devices which allow hatches to be opened and closed are called hatch covers. In general, hatch covers are between 45% and 60% of the ship's breadth, or beam, and 57% to 67% of the length of the holds. To efficiently load and unload cargo, hatches must be large, but large hatches present structural problems. Hull stress is concentrated around the edges of the hatches, and these areas must be reinforced. Often, hatch areas are reinforced by locally increasing the scantlings or by adding structural members called stiffeners. Both of these options have the undesired effect of adding weight to the ship.

As recently as the 1950s, hatches had wooden covers that would be broken apart and rebuilt by hand, rather than opened and closed. Newer vessels have hydraulic-operated metal hatch covers that can often be operated by one person. Hatch covers can slide forwards, backwards, or to the side, lift up or fold up. It is essential that the hatch covers be watertight: unsealed hatches lead to accidental cargo hold flooding, which has caused many bulkers to sink.

Regulations regarding hatch covers have evolved since the investigation following the loss of the MV *Derbyshire*. The Load Line Conference of 1966 imposed a requirement that hatch covers be able to withstand load of 1.74 tons/m^2 due to sea water, and a minimum scantling of 6 mm for the tops of the hatch covers. The International Association of Classification Societies then increased this strength standard by creating its *Unified Requirement S21* in 1998. This standard requires that the pressure due to sea water be calculated as a function of freeboard and speed, especially for hatch covers located on the forward portion of the ship.

Hull

Bulkers are designed to be easy to build and to store cargo efficiently. To facilitate construction, bulkers are built with a single hull curvature. Also, while a bulbous bow allows a ship to move more efficiently through the water, designers lean towards simple vertical bows on larger ships. Full hulls, with large block coefficients, are almost universal, and as a result, bulkers are inherently slow. This is offset by their efficiency. Comparing a ship's carrying capacity in terms of deadweight tonnage to its weight when empty is one way to measure its efficiency. A small Handymax ship can carry five times its weight. In larger designs, this efficiency is even more pronounced: Capesize vessels can carry more than eight times their weight.

Bulkers have a cross-section typical of most merchant ships. The upper and lower corners of the hold are used as ballast tanks, as is the double bottom area. The corner tanks are reinforced and serve another purpose besides controlling the ship's trim. Designers choose the angle of the corner tanks to be less than that of the angle of repose of the anticipated cargoes. This greatly reduces side-to-side movement, or "shifting," of cargo which can endanger the ship.

The double bottoms are also subject to design constraints. The primary concern is that they be high enough to allow the passage of pipes and cables. These areas must also be roomy enough to allow people safe access to perform surveys and maintenance. On the other hand, concerns of excess weight and wasted volume keep the double bottoms very tight spaces.

Bulker hulls are made of steel, usually mild steel. Some manufacturers have preferred high-tensile steel recently in order to reduce the tare weight. However, the use of high-tensile steel for longitudinal and transverse reinforcements can reduce the hull's rigidity and resistance to corrosion. Forged steel is used for some ship parts, such as the propeller shaft support. Transverse partitions are made of corrugated iron, reinforced at the bottom and at connections. The construction of bulker hulls using a concrete-steel sandwich has been investigated.

Double hulls have become popular in the past ten years. Designing a vessel with double sides adds primarily to its breadth, since bulkers are already required to have

double bottoms. One of the advantages of the double hull is to make room to place all the structural elements in the sides, removing them from the holds. This increases the volume of the holds, and simplifies their structure which helps in loading, unloading, and cleaning. Double sides also improve a ship's capacity for ballasting, which is useful when carrying light goods: the ship may have to increase its draft for stability or seakeeping reasons, which is done by adding ballast water.

A recent design, called Hy-Con, seeks to combine the strengths of single-hull and double-hull construction. Short for Hybrid Configuration, this design doubles the forward-most and rear-most holds and leaves the others single-hulled. This approach increases the ship's solidity at key points, while reducing the overall tare weight.

Since the adoption of double hull has been more of an economic than a purely architectural decision, some argue that double-sided ships receive less comprehensive surveys and suffer more from hidden corrosion. In spite of opposition, double hulls became a requirement for Panamax and Capesize vessels in 2005.

Freighters are in continual danger of "breaking their backs" and thus longitudinal strength is a primary architectural concern. A naval architect uses the correlation between longitudinal strength and a set of hull thicknesses called scantlings to manage problems of longitudinal strength and stresses. A ship's hull is composed of individual parts called *members.* The set of dimensions of these members is called the ship's scantlings. Naval architects calculate the stresses a ship can be expected to be subjected to, add in safety factors, and then can calculate the required scantlings.

These analyses are conducted when traveling empty, loading and unloading, when partially and fully loaded, and under conditions of temporary overloading. Places subject to the largest stresses are studied carefully, such as hold-bottoms, hatch-covers, bulkheads between holds, and the bottoms of ballast tanks. Great Lakes bulkers also must be designed to withstand springing, or developing resonance with the waves, which can cause fatigue fractures.

Since 1 April 2006, the International Association of Classification Societies has adopted the *Common Structural Rules.* The rules apply to bulkers more than 90 meters in length and require that scantlings' calculations take into account items such as the

effect of corrosion, the harsh conditions often found in the North Atlantic, and dynamic stresses during loading. The rules also establish margins for corrosion, from 0.5 to 0.9 mm.

Safety

The 1980s and 1990s were a very unsafe time for bulk carriers. Many bulkers sank during this time, 99 were lost between 1990 and 1997 alone. Most of these sinkings were sudden and quick, making it impossible for the crew to escape: more than 650 sailors were lost during this same period. Due partly to the sinking of the MV *Derbyshire*, a series of international safety resolutions regarding bulkers were adopted during the 1990s.

Stability problems

Cargo shifting poses a great danger for bulkers. The problem is even more pronounced with grain cargoes, since grain settles during a voyage and creates extra space between the top of the cargo and the top of the hold. Cargo is then free to move from one side of the ship to the other as the ship rolls. This can cause the ship to list, which, in turn, causes more cargo to shift. This kind of chain reaction can capsize a bulker very quickly.

The 1960 SOLAS Convention sought to control this sort of problem. These regulations required the upper ballast tanks designed in a manner to prevent shifting. They also required cargoes to be leveled, or trimmed, using excavators in the holds. The practice of trimming reduces the amount of the cargo's surface area in contact with air which has a useful side-effect: reducing the chances of spontaneous combustion in cargoes such as coal, iron, and metal shavings.

Another sort of risk that can affect dry cargoes, is absorption of ambient moisture. When very fine concretes and aggregates mix with water, the mud created at the bottom of the hold shifts easily and can produce a free surface effect. The only way to control these risks is by good ventilation practices and careful monitoring for the presence of water.

Structural problems

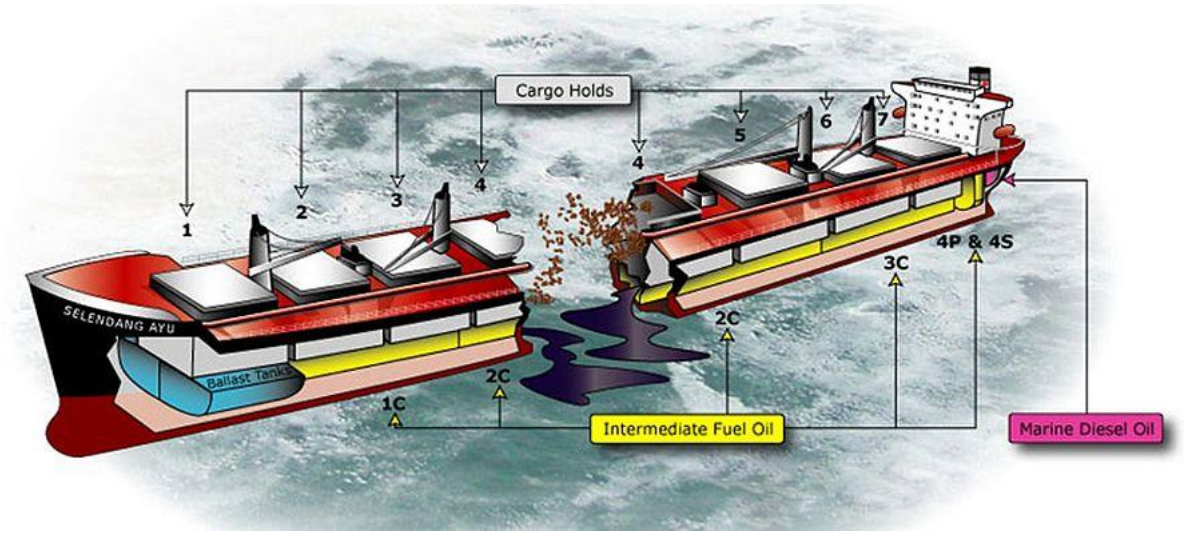


Diagram showing the wreck of the *Selendang Ayu*, and the double-bottom tank leaks.

In 1990 alone, 20 bulk carriers sank, taking with them 94 crewmen. In 1991, 24 bulkers sank, killing 154. This level of loss focused attention on the safety aspects of bulk carriers, and a great deal was learned. The American Bureau of Shipping concluded that the losses were "directly traceable to failure of the cargo hold structure"[31] and Lloyd's Register of Shipping added that the hull sides could not withstand "the combination of local corrosion, fatigue cracking and operational damage."

The accident studies showed a clear pattern:

1. Sea water enters the forward hatch, due to a large wave, a poor seal, corrosion, etc.

2. The extra water weight in hold number one compromises the partition to hold number two,

3. Water enters hold number two and alters the trim so much that more water enters the holds

4. With two holds rapidly filling with water, the bow submerges and the ship quickly sinks, leaving little time for the crew to react.

Previous practices had required ships to withstand the flooding of a single forward hold, but did not guard against situations where two holds would flood. The

case where two after (rear) holds are flooded is no better, because the engine room is quickly flooded, leaving the ship without propulsion. If two holds in the middle of the ship are flooded, the stress on the hull can become so great that the ship snaps in two.

Other contributing factors were identified:

- Most shipwrecks involved ships over 20 years in age. A glut of ships of this age occurred in the 1980s, caused by an overestimate of the growth of international trade. Rather than replace them prematurely, shipping companies were compelled on cost grounds to keep their aging vessels in service.
- Corrosion, due to a lack of maintenance, affected the seals of the hatch covers and the strength of the bulkheads which separate holds. The corrosion is difficult to detect due to the immense size of the surfaces involved.
- Advanced methods of loading were not foreseen when the ships were designed. While the new processes are more efficient, loading is more difficult to control (it can take over an hour just to halt the operation), occasionally resulting in overloading the ship. These unexpected shocks, over time, can damage the hull's structural integrity.
- Recent use of high-tensile steel allows building a structure with less material and weight while retaining similar strength. However, because it is thinner than regular steel, HT steel can corrode more easily, plus it can develop metal fatigue in choppy seas.
- According to Lloyd's Register, a principal cause of sinkings was the attitude of ship-owners, who sent ships with known problems to sea.

The new rules adopted in the 1997 annexes to the SOLAS convention focused on problems such as reinforcing bulkheads and the longitudinal frame, more stringent inspections (with a particular focus on corrosion) and routine in-port inspections. The 1997 additions also required bulkers with restrictions (for instance, forbidden from carrying certain types of cargoes) to mark their hulls with large, easy-to-see triangles.

Crew safety

Since December 2004, Panamax and Capesize bulkers have been required to carry free-fall lifeboats located on the stern, behind the deckhouse. This arrangement

allows the crew to abandon ship quickly in case of a catastrophic emergency. One argument against the use of free-fall lifeboats is that the evacuees require "some degree of physical mobility, even fitness" to enter and launch the boat. Also, injuries have occurred during launches, for example, in the case of incorrectly secured safety belts.

In December 2002, Chapter XII of the SOLAS convention was amended to require the installation of high-level water alarms and monitoring systems on all bulkers. This safety measure quickly alerts watch standers on the bridge and in the engine room in case of flooding in the holds. In cases of catastrophic flooding, these detectors could speed the process of abandoning ship.