Purpose of the present talk is to describe the pusher-barge transportation system we have developed for ILVA in the last three years.

The **ILVA Company** belongs to the Riva Group which is a conglomerate of companies operating in the iron and steel production industry and related activities. It is the outright leader of the sector in Italy, the sixth in Europe and ninth in the world.

This position was attained over half a century, as the result of an expansion policy which included the acquisition, restructuring and revitalization of several companies as “Siderurgica Sevillana” of Sevilla. But the most important of these was the privatisation in Italy of ILVA from IRI group in 1995.

Steel production and processing are integrated with other diversified and synergistic activities, such as: scrap recovery (one plant in Canada and one crushing plant in France); refractory material productions (six works in Italy), rolling cylinder manufacturing (one plant in Italy). The shipping business includes thirteen vessels, between them one ore carrier of 250.000 t DWT and four innovative just built barges of 30,000 t. DWT moved by two powerful pushers.

The **pusher-barge combination** is an interesting transportation system that allows flexible and inter-modal carriage of cargoes by sea.

The pusher barge is replacing the conventional towing of barges by cables. Low speed, directional instability, manoeuvring difficulties and poor control of the towed barge are some of the main disadvantages to operate a barge train in a towing mode.

Research and development of pusher-barge techniques in America and Europe were much different from those in Japan. In America and Europe, the pusher barge systems have been developed as means of traffic mainly in the navigable inland waterways.

On the contrary, Japanese owners needed to operate continuously the pusher-barge in “open sea” of Japan’s archipelagos from their first introduction.
At the beginning barges were coupled to pusher by steel wires/ropes and winches or permanently connected by bolted thick flanges; these have been progressively replaced by hydraulic mechanical locking systems to allow faster connections and improve safety.
The operational needs encouraged designers to study and implement modern types of connections. These connection systems are defined as permanent and removable connections.

Permanent connection

The pusher and barge cannot be disconnected in open sea. The connection and disconnection require calm sea and complex adjustment of trim and buoyancy to align the bearing surfaces and locking devices (bolts, hooks, etc…) in absence of relative motions between tug and barge.
This system is used for combinations intended to operate mainly in rivers.

Removable connection

The pusher and the barge can be disconnected/connected at sea (the system should be operated by one man in no more than five minutes).
Two types of removable connections are defined:
Rigid connection: no relative motions between tug and barge are allowed (three pins connection). This type has been installed in the ILVA fleet.
Flexible connection: the relative motion between the tug and the barge is allowed at sea, the tug is free to pitch with respect to the barge (two pins connection).

Let’s now illustrate the **new ILVA fleet**. The service of the new fleet takes place at 90% in Mediterranean Sea with cargo of steel product (coils, blooms, billets, rails, etc.) between the ILVA coastal steel plants of Taranto, Genoa, Ven-

ice/Marghera, Thessaloniki and Bizerte but mainly between the Italian ports of Taranto and Genoa.

The biggest ILVA plant is in Taranto, so this port is the most important for the intended traffic and is 2/3 days navigation far from all the other ports. As loading and unloading a barge lasts the same time, 2/3 days, the traffic assessment indicated that pusher-barge system is the best solution to implement a transportation chain.

The new fleet comprises six units, two pusher tugs and four hatch barges. This enables two barges to be under loading/discharging operations whilst the other two are being pushed to destination. On arrival each pusher can leave the barge at pier and engage the other barge which is ready to sail. This results in a maximum of 4 units, out of 6, sailing: two barges will be always in port and the pushers always in navigation, no time is lost to wait in the harbour. In the past (sometimes even now, when necessary) this service was carried out with four conventional self propelled vessels (bulk carriers of 28.000 t. DWT), which were able to perform one and a half trip each week whereas the pusher can make three voyages each week, doubling the effective number of trips. The fact that an effective total of four ships are operated using just two engine plants, replacing four conventional ships, achieves several technical, operational and environmental advantages.

In fact, the owners have found rewarding this transportation system for several reasons:

1) operating two engines plants instead of four and carrying twice quantity of cargoes in the same time and cutting the potential pollution by half;
2) employing 10 complements for each of the two pushers instead of 20 complements for each of the four conventional bulk-carriers reducing the complements to one fourth. This solution was allowed by the Italian Administration since the pusher itself is classed as “tug”, so with reduced crew list.

In addition the system grants other minor advantages such as:

- large breadth and smaller draught of units for river and shallow waters service;
- no restriction of trim/draft for connection/disconnection;
- mechanical/hydraulic coupling system remote controlled;
- strong and safer coupling systems;
- low-cost maintenance;
- reduced spare parts;
- fast unlocking operation (as required by international rules);
- one-man operation;
- unrestricted sea service;
- emergency operation in towing mode.

It is also correct to mention practically the only important disadvantage of the pusher-barge transportation system: the shape of the hull of integrated ship is worse than the one of conventional vessel so the water resistance is slightly higher as well as the fuel consumption.

Finally, as of particular interest for insurance purposes, the combined pusher/barge is an example of reduction of risk of total loss of the combination. In fact, in case of collision, grounding or other serious casualties, there's the possibility to disengage the hurt and very expensive part (the pusher) that can safely navigate alone abandoning the barge, reducing also the risk of loss of human life.

Concerning the **Main Characteristics and Class of the units**, they are reported in the very busy slides. I will not illustrate these slides today, there is no time. I will mention only some characteristics.

The pusher is 48 m long, propelled by two engines Wartsila for total 13.120 kW and two propellers. The barge is 190 m long, 30.000 t DWT, provided with bow thruster. The integrated ship pusher-barge is 205 m long, the service speed is 14,5 knots full loaded at 85% of maximum continuous rating.

The units have the highest Class RINA, the engine room is fully automated (unattended for 24 hours) in navigation and when berthed; the bridge is suitable for one-man operation. Barge connection and disconnection is remote controlled by one-man from the bridge.

Let's now move to a critical part of the system which is **the coupling**. The pusher enters 33 m the stern notch of the barge where she can be rigidly connected by a coupler system.

The three pin pusher barge coupler TRIOFIX type, made by Japanese TAISEI, is hydraulically operated with a 3 points supported rigid connection and is capable of ensuring excellent seaworthiness equivalent to that of a cargo ship. In addition it adapts itself to changes in barge draft and trim during loading and unloading.

As this rigid connection system does not allow relative motion between the pusher and barge, the clearance between the two hulls can be reduced to a minimum. This greatly reduces the generation of eddies and so allows the attainment of higher speed. The crew on board experience the same level of comfort as in an ordinary ship.

Connection by means of this coupler can take place at any draft, in very short time, by remote control from the bridge of the pusher. This can be achieved even in open sea where conventional pusher/barges have never formerly been capable of operation. In fact, the articulated coupler may have operational restriction in heavy weather to avoid large pitch angles and imposed acceleration.

With this type of flexible (or articulated or two pins) connection, generally with sea force 4 the pusher must be disconnected because the maximum allowable angle of 18 degrees between the trims of the two units is reached. Then the voyage must continue in towing mode. This problem obviously does not exist when pusher and barge are rigidly connected.

The rigid connection comprises two side transversal couplers and one bow longitudinal coupler, all fixed to the hull structure under the superstructure deck of the pusher. A notch in the barge stern houses three series of connecting slots with

relevant vertical racks (two in the side walls and one in the centre line of the notch) where the three pins of the pusher tug, hydraulically operated, can engage.
For safety reasons the couplers are provided with double electric and hydraulic circuits. While the IMO requirements indicate a maximum disconnection time of 5 minutes by one man control, the ILVA system can disengage in less than one minute.
We can conclude, as already mentioned, that the "integrated ship pusher/barge" has, at all effects, the same seaworthiness and safety of an ordinary ship.
The seaworthiness of the units was satisfactorily proved during the transfer of the first pusher-barge in loaded condition from China to Italy in June 2002, monsoon season; the combined unit of 205 m total length handled for several days heavy weather with steep waves, sea force 9/10, without any structural problem and without damages to equipments and coupling.
From enquires we made it results that the ILVA pusher-barge system is in the forefront; for sure it is, the only one in the world, suited for unrestricted ocean service.

Let's now answer to the actual topic of the meeting: **does she have class?** The answer is yes, she does have class. These ships, that are in compliance with Solas and Marpol requirements, are also in compliance with the "Italian regulation for the safety of navigation and life at sea".
As required by the Italian law, they were classified by an international classification society, the Italian RINA (Registro Italiano Navale).
RINA's engineers have carried out a study of the technical aspects of the integrated pusher barge system for the evaluation of new specific requirements as well as the use of the present ship technology, as applicable to these systems. In particular the following technical areas were investigated:
- seakeeping pusher/barge combined unit
- global bending moment and sheer force at sea

- local loads acting in way of connections
- stress analysis criteria of the connecting structural members.

These investigations have assessed the suitability of a removable connection of rigid type (three pins) for a large combined units intended to operate in open sea. Accordingly the vessel's design drawings, developed by the shipyard designers, were approved for the new constructions ordered by ILVA.

In addition to the approval of the construction drawings, the class has covered the construction survey, the materials testing and the sea trials at vessel's delivery.

The class grants the following advantages:

- recognized quality standards of the construction of hull, machinery, electrical installation, fire fighting and fire protection and of the stability
- periodical surveying of vessel in service for maintenance.

Only in case of small units (such as barges less then 200 GRT) for national service (coastal and river service) class is not required for Italian Flag registration. The vessel should comply at least with flag administration requirements regarding safety and navigability. In such case, the classification society, RINA in Italy, act as technical body of flag administration to witness the compliance with the applicable flag requirements for the intended limited service.

Notwithstanding OPA 90 issued by U.S. and MARPOL **double skin** for vessel it is not compulsory, since applicable only for oil tankers. The owners chose a double skin configuration that assure a physical separation of cargo area from the shell plates, even if the vessel is not intended to carry oil.