Technical Specification for Tank Mixers

1. Introduction

1.1 Scope

This standard specifies requirements and gives recommendations for the design, fabrication, assembly, testing, inspection and installation of side-entry mixers for storage tanks.

1.2. Applicability and regulatory considerations

This standard is intended for use in oil refineries, chemical plants, gas plants, exploration and production facilities and supply/marketing installations.

If national and/or local regulations exist in which some of the requirements are more stringent than in this manual, the contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable as regards safety, economic and legal aspects. In all cases the contractor shall inform Petrobras of any deviation from the requirements of this document.

1.3. Definitions

The **Contractor** is the party which carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project, or operation or maintenance of a facility. The Principal may undertake all or part of the duties of the Contractor.
The **Manufacturer/Supplier/Vendor** is the party which manufactures or supplies equipment and services to perform the duties specified by the Contractor.
The **Owner** is the party which initiates the project and ultimately pays for its design and construction. The **Owner** will specify the technical requirements. The **Owner** may also include an agent or consultant authorized to act for, and on behalf of him.
The word **shall** indicate a requirement.
The word **should** indicate a recommendation.

2. Purpose

Side-entry mixers are installed in storage tanks to fulfill one or more of the following duties:
a. BS&W
Control or prevention of accumulation of tank bottom deposits such as sand, silt, water, clay, paraffin, heavy ends or other waxy components, mainly in crude oil tanks. These deposits are commonly referred to as BS&W (Base Sediment and Water).

b. Maintain the homogeneity
Maintain the homogeneity of finished or intermediate products/feed stocks to ensure uniform product specification.

c. Blending
Blend different components to obtain a homogeneous blend in a specified time to specified requirements.
d. Heat transfer or to maintain temperature uniformity.

For **case a**, it is not necessary to mix the whole tank/vessel contents but to create a flow pattern in the lower part of the storage equipment.
In this case, the side-entry mixers are used before and during discharge so that:
-the solids are kept in suspension;
-the whole tank/vessel contents remain pumpable;
-the tank/vessel bottom will suffer less from corrosion because the stagnant layer, containing mostly salt water and other corrosive media, is replaced by a less corrosive mixture;
-laborious and costly tank/vessel cleaning is required less frequently;
-discharging slugs of water, with consequent process upsets, will be prevented.

For cases b, c and d complete movement throughout the tank/vessel with top to bottom "turnover" as well as circulation round the tank/vessel will be required to ensure that the total liquid content is uniform to specification.
For heat transfer duty the locations of the mixers relative to the heating elements are important to the success of the application.

At least one of above described duties shall be filled in on data/requisition sheet, including a blending time for case c.

3. Design and engineering
Data/requisition sheet shall be used for the exchange of information between Owner, Contractor and Manufacturer.
Where the data/requisition sheet shows alternatives, those items which are not applicable shall be deleted.
Design and construction shall be proven in practice, robust and reliable.
The Manufacturer shall obtain from the supplier the material quality certification for all raw materials of construction used, meeting the requirements specified.

3.1. Area classification
Electrical equipment shall be suitable for the hazardous area classification (see IP Model Code Part 15) in which it will be installed and shall have a type of protection in accordance with IEC 60079-14.

4. Specification for side entry mixers
4.1. General
Side-entry mixers shall be of turbulence recirculation type and either of the fixed-offset angle type or of the swivel angle type. In both cases, the direction of rotation, as seen from the motor and looking towards the propeller, shall be clockwise and the pumping action shall be away from the tank or vessel shell.
For petroleum storage tanks and other products that deposit slurry during the operation, the mixers swivel angle type shall be used.
The design shall allow for installation or removal of the mixer assembly (including the propeller) from the tank/vessel simply by bolting or the mounting nozzle cover on which the mixer is assembled.
Side-entry mixers shall be supplied assembled, complete with appropriate mountings and ready for installation.

4.1.1. **Fixed-offset angle type**
Fixed-offset angle type side-entry mixers shall be used for blending or homogenizing purposes.
The fixed-offset angle shall be to the left of the tank radius running through the centre of the mounting flange cover in which the mixer is to be installed. A mounting adapter angled at ten degrees shall be used for all tank sizes.

4.1.2. **Swivel-angle type**
Swivel-angle type side-entry mixers shall normally be used for BS&W control, with occasionally a further requirement for blending.
The swivel mechanism shall be manually operated, and shall be capable of moving the propeller shaft in the horizontal plane between 30 degrees left and 30 degrees right of the tank radius or vessel radius through the centre of the manhole cover. It shall have a facility for setting the propeller angle, in relation to the tank or vessel, in the zero position and at 10, 20 and 30 degree angles both left and right of the zero setting. The angle settings shall be clearly marked and a device shall be provided to ensure that the mixer remains securely locked at the selected angle during operation.
The swivel mechanism shall be designed for heavy duty. The spherical ball on which the mixer swivels shall be of austenitic stainless steel (AISI 316 type material as minimum). The hardness

difference between ball and swivel mechanism shall be greater than 150 H Brinell., in order to minimize wear. The spherical ball shall be polished to a surface finish smoother than 0.4 microns Ra.
The seal between the moving and stationary parts shall be compatible with both the product and salt water and shall be capable of withstanding a five (5) year period in the environment without any maintenance, apart from occasional tensioning of the packing gland nuts.

4.2. Power
Petrobras will supply the electrical power (further information latter) ……..

4.3. Electric drive
The side-entry mixer shall be driven by an electric motor which shall comply with Petrobras requirements (further information latter).
The mixer and its driver shall be suitable for continuous operation and shall be suitable for the hazardous area classification.
For bearing life expectancy refer to (4.8).
For all electric motors, requisition sheets according to (further information latter) shall be completed by the electric motor Manufacturer.
The mixer data sheet shall specify how the driver shall be connected to the side-entry mixer: gear box or belts drive transmission set.
Care shall be taken that the drive-end bearing of the electric motor is capable of accepting the forces associated with belt drives.

4.4. Transmission
4.4.1. General
The following drive transmissions are acceptable and listed in order of preference:
-Tooth belt drive;
-Direct single or multi V-belt drives and wedge belt drives;
-Spiral bevel gear and hypoid bevel gear transmission;
-Combined helical gear transmission and V-belt drive;
-Worm gear transmission.
In general a belt drive is preferred because the purchase and maintenance costs of gearbox drives are expected to be higher.
V-belts, multi-V-belts and tooth belts shall conform to one of the following specifications:
-API1B;
-BS 3790 and BS 4548;
-ISO 4184; or
-DIN 7753 parts 1 and 2.
Belts shall be oil resistant in accordance with BS 903 part A16, as well as fire resistant and anti static "FRAS" conforming to BS 3790.
For general information on electrical resistance of conductive and anti-static products made from polymeric material see BS 2050.
Belts shall be durable and shall be marked legibly on the non-working face, indicating the belt type (for wedge belts: SPZ, SPA, SPB or SPC; for V-belts: Y, Z, A, B, C or D and for tooth belts: XL, L, H, XH or XXH), belt cross-section, nominal pitch length and FRAS properties. Belt drives shall not be used with two-pole motors.
The belt pulleys shall conform to BS 3790 or BS 4548 and have taper lock bushes for ease of removal.

4.4.2. Tooth belt drives
Toothed belts shall be of the high torque drive (HTD) type conforming to BS 4548. The tooth belt polyester tensile cores shall be helically wound, to create strength, flexibility and resistance to elongation. The belt tensile member shall be encased by neoprene teeth and backing. The wearing surfaces of the belt shall have a nylon facing to minimise friction.

4.4.3. V-belt drives and wedge belt drives
Wedge belts (narrow V-belts) are preferred to classic V-belts.
Design calculations for wedge and V-belt drives shall be in accordance with Appendix A of BS 3790. For determining the power transmission capability a service factor of 1.3 shall be used.
Wedge belts or V-belts shall only be used for duties up to 20 kW.
Integral multi-wedge belts or multi-V belts of the endless type shall be used for duties from 20 kW up to 55 kW. However, these multi-belts ("concorde-belts" or "poly-belts") are usually not available for all mixer power/speed combinations. Integral multi-belts are preferred over wedge belts and V-belts because their service life is approximately 5 times longer.
Wedge and V belts shall have a polyester core, a neoprene filler and neoprene impregnation.

4.4.4. Gearbox drives
Gear units shall comply with API 677. A gearbox drive shall utilise high efficiency spiral bevel gears according to AGMA 6010 and shall have a minimum load (service) factor of 1.5 or shall have helical gears made of die-forged, precision hardened steel. The gears shall be splash oil lubricated. The gear housing should be suitably sized to ensure adequate heat dissipation and noise levels as specified in equipment noise limitation sheet, PTS 31.10.00.94. The gearbox shall be constructed with an inspection cover for inspection of the gears. The gearbox shall be removable for shop maintenance as one unit, without disturbing motor mounting alignment or removing coupling halves.

4.4.5. Coupling
The coupling between the gearbox and the motor shaft shall be of the non-lubricated disc pack spacer type. The flexible coupling element between gearbox and motor shall be in accordance with DIN 28155 or BS 3170.

4.4.6. Guards
Rotating parts of the transmission shall not be left exposed. Belt guards or coupling guards for gear type transmissions shall be made of weatherproof and non-sparking material, in accordance with BS 5304. They shall be permanently fixed and sufficiently rigid to prevent contact with moving parts and be designed for easy removal and assembly.

4.5. Propellers
4.5.1. Fabrication
Both cast marine type propellers and welded propellers are considered suitable for use with side-entry mixers.
If a welded propeller type is offered, only full penetration welds are acceptable. The propeller shall be checked thoroughly for welding defects, especially at the blade root, where stresses are at a maximum.
The propeller material shall be compatible with both the product and salt water.
The propeller shall be locked to the shaft. Positive fixing of the propeller to the shaft may be achieved by taper to taper, side fitting key and a corrosion resistant impeller retainer cone with cap screw. Keys are not allowed if cladded shaft material is used.
All propellers shall be statically and dynamically balanced in air as well as hydraulically balanced to ensure vibration free operation, optimum cavitations free conditions and promoting maximum pumping rate and entrainment for any given power.

4.5.2. Inspection
Propeller surfaces shall be free of adhering sand, scale, cracks and hot tears. Other surface discontinuities shall meet the visual acceptance standards specified in MSS SP 55.
Welded propellers shall be radio-graphically inspected in accordance with ASTM E 94. The interpretation of radiographs shall be in accordance with ASTM E 186, ASTM E 280 or ASTM E 446, whichever is applicable. The acceptance criteria shall be proposed by the manufacturer for the approval of the Principal.
Ultrasonic inspection in accordance with ASTM A 609 shall be performed if radiography is not

possible.
The final arithmetic average blade surface roughness of the propellers shall be smooth finish (Ra 3.2 to 6.3 microns).

4.6. Shaft
a- Hard coated at seal and shut-off areas
b- Shall permit to be monitored during operation

4.7. Shaft seals
Either a mechanical seal or a packed stuffing box shall be applied for sealing the mixer shaft.
4.7.1. Stuffing box
A packed stuffing box shall be used only for water and comparable products, because this type of seal tends to leak due to the degradation of the sealing elements.
Furthermore the use of a stuffing box as pressure sealing device shall be restricted to pressures up to 4 bar (ga) and a maximum product operating temperature of 100°C.
The packing for the stuffing box shall be selected from a range of self-lubricating packing not requiring lubrication and shall be compatible with both the product and salt water.

4.7.2. Mechanical seals
Mechanical seal arrangements and materials shall be as specified in data/requisition (further information latter)
To ensure selection of the optimum mechanical seal for the duty specified, the mixer manufacturer shall make available to the seal manufacturer a copy of mixer data/requisition (further information latter) .
The mixer manufacturer shall be responsible for the functioning and installation of the mechanical seal and its auxiliary facilities.
Single unbalanced mechanical seal shall be used as pressure sealing device for pressures up to 10 bar (ga). The mechanical seal shall have a provision for venting the seal chamber to ensure that it is completely filled with liquid prior to start-up.
A back-up bushing of non-sparking material having a small clearance shall be provided in the flange or housing in order to restrict the product leakage rate in the event of a mechanical seal failure.
Materials of construction in contact with the tank contents or vessel contents shall be compatible with both the product and salt water.

4.7.2.1. Mechanical seal coding
Mechanical seal piping/schematics, mechanical seal material specifications and mechanical seal classification codes shall comply with API Std 682.

4.7.2.2. Temperature limits for mechanical seal gaskets
The temperature limits for the materials of the seal gaskets shall be as follows:
a-synthetic rubbers from minus 15°C up to maximum 100°C,
b-Viton from minus 15°C up to maximum 200°C,
c-PTFE (Teflon, Fluon): from minus 100°C up to maximum 225°C,

4.7.2.3. Flexible sealing member
A solid PTFE “G” ring is not a good flexible sealing member between the rotating seal part and the shaft sleeve, because after several pressure cycles it tends to leak.

4.7.2.4. Mechanical seal piping
Provisions shall be made to ensure optimal operating conditions for the mechanical seal. Means by which this is to be achieved shall be indicated in the mechanical seal data/requisition sheet by reference to the appropriate plan in Appendix D of API 610.

4.7.2.5. Circulation of flushing fluid

Only a fixed orifice shall be used to restrict the circulation of the flushing fluid. Where the pumped liquid contains abrasives, a clean flushing medium, from an external source and compatible with the mixed fluid, shall be used.

4.7.2.6. Quench fluid
A quench fluid shall be used under the following conditions:
-where leakage of liquid from the tank or vessel to atmosphere could become a potential source of fire hazard.
-where leakage of liquid to atmosphere could endanger personnel due to toxicity.
-where the liquid would crystallize on exposure to atmosphere.

4.7.2.7. Special applications
Where required by local safety regulations, a single mechanical seal with a gas back-up seal and a nitrogen purge or, alternatively, double mechanical seals with an external sealing medium shall be specified.

4.8. Bearings
a- All bearings shall be located outside tank
b- Permanently greased for life
c- 40,000 hours life minimum

4.9. Bearing lubrication
To be specified per Manufacturer.

4.10. Optional devices
Special provisions may be required for mixers operating under certain severe or hazardous conditions.
The following optional devices for avoiding process fluid losses or damage to the environment have been developed and are presently available on the market.

4.10.1. Ignition gap
To allow the operation of side-entry mixers in hazardous areas, a special safety feature may be installed. This is a close clearance bushing to prevent combustion caused by a spark or flame entering an area which may be laden with an explosive gas. Both the clearance between motor output shaft and this bushing and the bushing length parallel to the motor shaft shall be selected such that any flame outside the motor housing will have insufficient oxygen to allow combustion to be sustained as it attempts to travel the distance along the motor shaft. This feature may be installed on both fixed-offset angle type side-entry mixers and swivel angle type side-entry mixers. For fixed-offset angle type side-entry mixers it consists of an ignition gap at the shaft entry into the storage tank/vessel. Swivel angle type side-entry mixers may be designed with an ignition gap at the stuffing box flange of the swivel device.
The Manufacturer shall submit a certificate stating that operation in the specified hazardous area is permitted with respect to static electricity.

4.10.2. Bearing protection system
This system provides the user with a simple, easily operable and highly reliable system to warn of impending bearing failure. The units shall be intrinsically fail safe.
The system comprises an electronic protection unit, which is installed inside a flame proof enclosure and is interconnected by core screened cables to one or more probe assemblies.
All probes mounted on the mixers are connected in series so that, if anyone wire becomes an open circuit or a high resistance connection, the electronic protection unit shall initiate a trip of the mixer with the impending bearing failure.
Two probe assemblies for each mixer shall be mounted in the vertical plane in a split housing. The probe adjustment shall be implemented by a spring-loaded dial at the top of each probe, giving adjustment in approximately 0.025 mm steps. The setting should be 0.050 mm.

4.10.3. Automatic swivel actuation system
This "swivel-angle" feature of side-entry mixers can effectively be applied for the resuspension of tank bottom sediment.
It assures that the side-entry mixer continually moves across its sixty degree angle, from the left to the right and back to the left, over a period of approximately 10 hours running time. This system operates automatically and directs the propeller flow stream periodically towards deposits lying widespread on the tank floor. Consequently no manpower will be needed to change the entry angles of installed swivel-angle mixers periodically.
In cases where multiple mixers are installed on one tank it will be necessary that all sideentry mixers operate "in phase", or at the same relative entry angle. "In phase" operation of the side-entry mixers in phase has to be checked at regular interval times.
The mechanical actuator shall be designed such that the mixer entry angle can be quickly adjusted to match those of other mixers on the tank. The power consumption of this device shall be minimum.
The automatic swivel actuator shall be so made that it will be possible to retrofit "older" swivel-angle mixers without concern for modifications to power sources.
The Manufacturer shall submit installation instructions complete with a lubrication schedule.

4.10.4. Automatic belt tensioner
If applicable, the automatic belt tensioning device shall consist of an adjustable spring, encased in a housing and connected to one end of the motor base plate. The base plate shall have sufficient stiffness, to avoid misalignment.

4.11. Lifting lugs
All mixers and electric motor have to be provide with lifting lugs, to allow the installations and removal.

4.12. Tie-Rod/Pedestal Support And Brackets
Mixers with a total mass of 700 kg and above require additional supports by means of tie rod(s) or a special pedestal support, unless it can be proven that the tank shell will not be over-stressed according to API Std 650. The complete mixer support arrangement shall be thoroughly designed to account for all possible loadings, including interaction between fixed points, fixing devices, nozzle welds and materials of construction.
For swivel-angle type mixers only one centrally mounted tie rod shall be installed.
Where a sling support cannot be used, a spring loaded castor or pillar type support may be fitted to either fixed type or swivel-angle type side-entry mixers.
To accommodate deflections in the tank shell or vessel shell during filling and emptying cycles, particularly with highly stressed tanks or vessels, the tie rods shall incorporate variable load or constant load support springs to ensure that forces imposed on the tie rods during tank or vessel movement do not include excessive bending moments on the side-entry mixer mounting nozzle.
After bolting the mixer onto the mounting nozzle, the tie rods and castor support shall be adjusted to just carry the mixer weight. This shall be carried out with the tank empty. Care shall be taken not to over-stress the tie rods or pedestal support, which would cause distortion of the mixer shaft.
Tie rod brackets shall be suitable for welding to the tank/vessel shell and shall be executed as shown in Appendix 3.
For new tanks tie rods and brackets shall be supplied by the tank/vessel Manufacturer, but construction details shall be provided by the side-entry mixer Manufacturer.

4.13. High temperature side-entry mixers
4.13.1. General
High temperature side-entry mixers are those required to operate in a product with a temperature range between 120°C to 250°C. This is mainly for bitumen blending services.
For mixers operating in this temperature range the following specific requirements apply:
-mixer parts shall not be made of rubber;

-jacketed bearing housings with flanged in/outlets shall be fitted where bearing temperatures are likely to exceed 70°C without cooling;
-in case product solidification may occur at ambient temperatures. heat tracing, by means of steam jacketing, around the mechanical seal chamber shall be fitted. The steam jacketing shall be suitable for saturated steam at 300 kPa to 350 kPa;
-the electric motor shall be specified correctly for the ambient cooling air conditions.

4.13.2. High temperature grease purge system
To ensure satisfactory operation of mixers at temperatures above 120°C, which have the mechanical seal installed remote from the tank contents, an extended cavity high temperature grease purge system shall be installed.
The tank product (A), which enters the high temperature mixer body around the shaft, shall come in contact with and be diluted by a high temperature, product soluble grease (B). After a certain period of regular operation the grease becomes saturated with tank product. Fresh grease shall be pumped into inlet (C), and diluted grease shall be purged through the drain connection (D).
The grease purge system shall allow safe and reliable re-packing at regular intervals, as given by the service instructions.
The system shall allow the use of both a high temperature primary mechanical shaft seal and secondary back-up emergency seal (E).
Only special high temperature grease for re-packing the grease purge system shall be applied.

4.14. Shut-off devices
4.14.1. Mixer end closure
When necessary to enable maintenance/replacement of the mixer shaft mechanical seal or gland packet stuffing box and/or bearings without creating the risk of product leakage from the storage equipment, a hand operated wear resistant end closure shall be installed.
This device shall: -have a sealing face or collar machined or welded onto the shaft. A removable sealing face is not acceptable; -be capable of tight shut-off at not less than twice the maximum pressure of either the product or salt water (if applicable), whichever is greater; -incorporate a checking device to ensure that shut-off is 100% effective prior to dismantling;
-have a positive locking action, e.g. tapered metal to metal seal faces positively clamped by a bolted flange (thus eliminating the use of perishable rubbers and bayonet locking devices), so that it will not become loose accidentally whilst maintenance is being carried out;
-remain operative when not used for periods of up to five years in an open air and hostile environment.
Materials of construction for all component parts shall be compatible with the product in the storage tank/vessel throughout its operating temperature range, and with salt water.
The procedure for operating the shut-off device shall be as simple as possible, require no special tools and be clearly stated on a corrosion resistant plate mounted on the mixer mounting nozzle.

4.14.2. Seal leakage detection and control system
For tanks/vessels containing volatile liquids, which may be inflammable or explosive, and which are located in a hazardous area, a leakage control system, consisting of a radial shaft seal at the fluid end, a pneumatically or hydraulically operated emergency collar seal and/or a mechanical seal at the atmospheric end of the mixer may be installed. (Refer to Appendices 4 and 5.)
The space between the radial shaft seals and the mechanical seal shall be filled with a non-flammable oil which will prevent the penetration of sparks. This oil will also contribute to an improvement of the bearing and seal lubrication, resulting in a longer service life. A pressure operated shut down switch shall automatically stop and seal the mixer when any leakage takes place.
The actuation of this device should be either by a leakage detecting instrument, or a differential pressure indicator positioned between the two sealing systems. The location of the automatic shut down device, directly at the shaft entry point to the tank, shall ensure a prompt shut down of the mixer in case of serious damage by external forces resulting in a rupture of bearing and sealing support sleeves. Due to material constraints the use of this safety device shall be limited to

temperatures of maximum 90°C.

4.14.3. Emergency seal for high temperature side-entry mixers
For process fluids operating at temperatures above 100°C, which have the tendency to harden or to become sticky (e.g. bitumen), a remotely operated emergency seal may be installed.
This emergency seal may be remotely actuated by means of levers and rods or hydraulic actuators from a safe distance, in order to minimize the danger to personnel during maintenance or repair on the mixer. For sealing, the ring shall be squeezed between two metallic counter pieces, one of which shall be designed as a movable piston which shall slide via a bayonet type set ring. The radial motion of the set ring is thereby converted into an axial motion of the piston. Since infrequent operation with this device can be expected its reliability over a long period of time in exposed positions shall be guaranteed by the Manufacturer.

4.14.4. Low liquid level trip
In order to prevent build-up of static electricity in fixed roof tanks, there shall be a minimum liquid level of 2 m above the propeller tip. The low liquid level trip shall be connected to the mixer control system in order to shut-off the side-entry mixer.
The Owner shall specify who (tank/vessel Manufacturer or mixer Manufacturer) will deliver the low liquid level indicator. .

4.16. Noise control
According to Brazilian Regulation Norma Regulamentadora NR-15.

4.17. Data and information to be submitted
4.17.1 Data and information to be submitted with the tender
The bidder shall submit sufficient drawings and detailed information with their tender to enable a full evaluation of the side-entry mixer(s), including as a minimum:
- production and engineering documents schedule;
- general arrangement sketch (lay-out drawing), showing:
- number, size and preferred location of the mixer mounting nozzles required;
- distance between propeller and tank wall and tank bottom;
- shaft diameter, total length of mixer shaft;
- make, type and sketch of coupling and driver;
- parts lists, with references to ASTM designations (or equivalent);
- mass of the completely assembled mixer (including motor, gearbox);
- propeller diameter and pitch;
- required thrust, hydraulic power and installed motor power and speed;
- mechanical seal arrangement drawing and/or other shaft seal details;
- details of shaft shut-off device;
- details of swivel-angle mechanism (for swivel-angle mixers);
-list(s) of all recommended spare parts for initial and normal operation, as specified in Material Requisition, with detailed unit prices;
- proposals for fabrication and inspection plans;
-proposals for equipment test run programs, to be carried out both at Manufacturer's works and at site;
- names of all proposed sub-suppliers with a full description of the equipment being supplied by them;
- guaranteed sound power levels and/or sound pressure levels, at both minimum and maximum speed of the completely assembled mixer, together with any other relevant information as requested in the equipment noise limitation. The Manufacturer shall indicate what special silencing measures, if any, will be applied in order to meet specified levels;
- all further information asked for on the data/requisition sheet for side-entry mixers. -list(s) containing all deviations from this specification;

4.17.2 Data and information to be submitted after award of order

After award of contract a complete set of engineering documents shall be submitted for approval of Petrobras, before any shop or construction work is commenced. The number and type of documents shall be specified on the requisition for engineering documents (further information latter)
All documents shall be marked in the right-hand bottom corner with the Owner's order and item number, together with the Manufacturer's references.
After approval, certified final documents/manuals and electronic copies of drawings and all documents of the equipment shall be submitted to the Owner. The required number and type of final documents shall be specified in the requisition for engineering documents (further information latter).
NOTES;
1. All information. including the manuals for operation and maintenance. shall be clear and not open to misinterpretation and shall apply specifically to the equipment supplied.
2. For drawing presentation the "American Projection Method", according to ISO 128, should be applied. The characteristics of the projection method used shall be shown on the drawing.

5. Installation of side-entry mixers

5.1. Tank data

Usually, the tank and the mixing equipment will be supplied by different Manufacturers. Since the side-entry mixer, the supporting structure and the vessel or tank shall form an integrated unit, close collaboration between these Manufacturers is essential. The mixer Manufacturer shall inform Owner at an early stage about required dimensions of the mixer entry nozzle(s), estimated weights, torques, forces and bending moments acting on nozzles and on baffles or any other part which may influence the tank/vessel design. Both Manufacturers shall inform each other and the Owner as soon as possible about any changes in design or other reasons influencing the fabrication of the complete unit.
For all tanks, data such as volume, diameter, type of roof and bottom, including location of the heating coils where applicable, shall be specified by the Owner on data/requisition sheet for side-entry mixers (further information latter).
The orientation and elevation of the product inlet and outlet nozzles, in relation to the side-entry mixer mounting nozzle(s) and coils or other tank/vessel internals, shall ensure that no part of the fluid is able to bypass the mixing flow pattern.
For new tanks/vessels, it will be necessary to specify both the position and size of the mixer mounting nozzles at an early stage of equipment ordering, as some heat treatment of the lower course of the shell plates may be needed.
Both static and dynamic moments shall be checked against the appropriate design code, as well as static and dynamic stresses at the top edge of the reinforcing pad. Deflections of the material just outside the mixer entry nozzle and around the reinforcing etc. shall also be checked.

5.2. Mounting of side-entry mixers

Side-entry mixers shall be placed on manhole-type shell nozzles and shall be supplied with the appropriate mountings. For mounting nozzle sizes and details, refer to Appendix 3 and Appendix 4. Manholes required for tank access shall not be used.
610 mm diameter (24 inch) shell nozzles, according to API Std 650, shall be used for propellers up to and including 785 mm (30 inch) diameter.
Especially for mixers having propellers above 785 mm (30 inch) diameter, which are normally installed in large tanks, the complete mixing unit should be able to be removed without entering the tank (since it is more difficult to empty the tank and clean the floor sufficiently to enter the tank safely). Consequently, for propellers above 785 mm (30 inch) diameter up to and including 889 mm (35 inch) diameter API Std 650, class 150, 30 inch shell nozzles shall be used.
Fixed-offset angle side-entry mixers shall be mounted on a flanged nozzle welded to a mounting nozzle cover (see appendix 3). This nozzle flange shall be class 150 according to ASME B16.5 up to and including 610 mm (24 inch), unless otherwise specified.
Flanges for nominal pipe sizes over 610 mm (24 inch) shall be in accordance with ASME B16.47.
Swivel-angle type side-entry mixers shall be mounted directly onto a mounting nozzle cover.

5.3. Location of side-entry mixers
In order to locate the side-entry mixers, the mounting nozzles shall be positioned in accordance with the following requirements:
5.3.1. For blending, homogenizing and temperature uniformity
The first mixer shall be positioned at an angle of 22.5 degrees in a clockwise direction from the product inlet nozzle (see Appendix 1), otherwise a dead flow will occur. If more than one mixer is required, the second mixer shall be located at 22.5 degrees from the first mixer and in the same (clockwise) direction, and so on, to ensure that the inlet stream has an additive effect with the mixer propeller jet stream.

5.3.2. For cleaning and BS&W control
The first mixer shall be positioned opposite the product outlet nozzle, because the sideentry mixers can be varied to direct the flow up to 30 degrees either side of the tank or vessel centre line. Where more than one mixer is required, they shall be positioned in the quadrant opposite the product outlet nozzle (see Appendix 2).

5.3.3. Limiting conditions on tank and vessel shells
Mixers shall not be located on a weld seam. Further details are specified in PTS 34.51.01.31. If the intended positioning of the mixers would violate this requirement then the angle of 22.5 degrees may be increased. However, repositioning of the product inlet/outlet nozzle, as appropriate, should be considered in order to comply with the angles specified.

5.4. Propeller clearance
5.4.1. Minimum clearance between propeller and tank/vessel wall and bottom or heating coils.
The clearance between the nearest obstruction (heating coil, bottom, wall or roof) around the arc swept by the propeller tip shall not be less than 150 mm. However, in the case of a combination of a small propeller and a long nozzle, the clearance between the back side of the propeller and the wall. may be reduced to an absolute minimum of 140 mm.
For additional information refer to Appendix 3.

5.4.2. Minimum clearance between propeller(s) and tank roof.
5.4.2.1. For floating roof tanks
To protect the floating roof from being damaged, a trip device shall be fitted to stop the mixer running when the liquid in the tank reaches a level such that the clearance between the underside of the floating roof pontoon and the highest point of the propeller arc becomes less than 2.5 times the propeller diameter.
After cut out (when the mixer is not operating) the lowest position of the underside of the floating roof shall be a minimum of 150 mm above the swept arc of the propeller.

5.4.2.2. For fixed roof tanks and vessels
For fixed roof tanks the distance between the highest point of the propeller arc and the fixed roof shall be not less than 2.5 m.

5.5. Electricity supply
The clearance between fixed conduits and mixer motor shall be sufficient for all operating conditions, taking into account the possible movement in a tank/vessel between full and empty situation.
The outlet of the cable from the conduit shall be sealed to prevent ingress of water.
For swivel-angle mixers, a flexible cable with metallic protection between the motor terminal box and a junction box fixed to the structure shall be installed.
The location of the junction box shall ensure that there is sufficient slack in the flexible cable to allow the swivel-angle mixer to be rotated the full 60 degrees without overstressing. The cable shall include a full current-carrying earth wire and an earthed screen.

6. Additional requirements

6.1. Flange face surface finish

The equipment flanges shall have raised faces in accordance with ASME B16.5.
If the tank manhole type shell nozzles are executed with flat face flanges then the manhole cover flanges shall also have a flat face and full face gaskets.

6.2. Nameplates, Rating Plates, Asset Number Plates

Each mixer shall be provided with a nameplate made of corrosion resistant metallic material. Enameled nameplates shall not be used.
The asset number plate and rating plate of the electric motor shall be in accordance with PTS 33.66.05.31 .
The name and identification plate shall be attached using 4 mm diameter rivets to a no removable part of the equipment and shall be clearly stamped with the following information:
-manufacturer's name;
year of fabrication;
-Shell purchase order number;
-manufacturer's work identification number;
-equipment item number;
-equipment type, model and serial number;
-equipment weight.
The language on the nameplate shall be as stated on data/requisition sheet (further information latter).

6.3. Surface protection, painting and coating

6.3.1. Surfaces to be protected
In general, surfaces in contact with process streams, such as the mixer shaft and flange facings, etc. shall not be painted. All machined surfaces and threads shall be thoroughly cleaned and protected with Shell Ensis Fluid "G" or equivalent, unless otherwise specified.

6.3.2. Surfaces to be painted
Metal parts exposed to the atmosphere, such as outside surfaces of the mixer and supports, shall be shop painted in accordance with Petrobras standards (further information latter).

7. Inspection And Testing

7.1. General

The side-entry mixer shall be inspected and tested by the Manufacturer at the Manufacturer's works and at site to prove its capability and compliance with the purchase order requirements.
In the purchase order it shall be specified if, and to what extent, the inspections and tests at the Manufacturer's works are to be witnessed by the Owner.
The Manufacturer shall forward all test results and certificates of all tests to the Owner.
On completion of all tests, the mixer shall be drained, flushed and preserved, to ensure no deterioration occurs during storage and transportation to site.

7.2. Inspection and testing at the manufacturer's works

This shall include at least the following:
-General document control and check on materials used;
-General check on workmanship and dimensional check;
-Pressure test / leakage test;
-Wet performance test run.

7.2.1. Control of documents and materials used.
All required material certificates shall be available, and shall be checked for compliance, before assembly.

7.2.2. Workmanship and dimensional check.

A check on workmanship and a dimensional check of the completely assembled side-entry mixer shall be performed, and this shall include:
-correct fabrication, mounting and welding;
-alignment and tolerances of electric motor, mixer shaft and coupling;
-quantity and quality of oil lubrication needed for the mechanical seal system of the side
- entry mixer(s); -flushing flow rate for bearing lubrication;
-propeller smooth surface finish check;
-propeller pitch to diameter ratio to check hydraulic efficiency;
-static balance test and dynamic balance test of complete mixer shaft/propeller assembly;
-belt tensioning, to ensure full transmission of power to the propeller;
-swivel angle test and check of proper functioning of the locking device;
-paint thickness and quality;
-mixer overall dimensional check;
-check for nameplate;
-dimensions of mixer mounting nozzle cover plate;
-direction of rotation of the electric motor in relation to the proper pumping action of the propeller.

NOTES:
1. The mixer shaft shall be checked for straightness by placing it on V-blocks and measuring deflections while rotating by hand.
2. The variation between maximum and minimum blade tip radii shall not exceed 0.2 mm. At the tip and at two equal distances along the radius, the vertical height of corresponding points on the blade profile shall not differ by more than 2 mm between any two blades.

7.2.3. Pressure test/leakage test.
A hydrostatic pressure test of the mixer body, mechanical seal, lock seal, gland packing and outer tube assembly shall be carried out for each side-entry mixer, with and without its shut-off device operated.
The swivel-angle packing gland, mixer shut-off device and mixer adapter flange/mounting cover plate shall be checked for product leakage.
The gearbox shall be checked for oil leakage, if installed.
There shall be no leakage.
The test pressure shall be based on the maximum operating conditions of the tank or vessel on which the mixer will be mounted. The test pressure and time shall be specified on data/requisition sheets PTS 31.51.10.93., and shall be indicated on the relevant certified equipment drawings.

7.2.4.Wet performance test run.
The Manufacturer's test procedure and acceptance criteria shall be proposed by the Manufacturer for the approval of the Principal. A wet performance test run of at least 4 hours shall be carried out with one side-entry mixer of each series of the same design at the Manufacturer's works, unless otherwise stated in data/requisition (further information latter).
The mixer shall be mounted on a test tank and submerged in process liquid or a suitable substitute which has a similar density and viscosity as the actual process fluid. In case of an application with a range of viscosities and densities the worst case scenario shall be checked with respect to power draw and torque. The conditions of the test tank (such as capacity, service liquid, liquid height, pressure and temperature) shall be recorded. The performance test run shall be carried out at atmospheric pressure. At 30 minute intervals the following observations shall be recorded:
A check on workmanship and a dimensional check of the completely assembled side-entry mixer shall be performed, and this shall include:
-correct fabrication, mounting and welding;
-alignment and tolerances of electric motor, mixer shaft and coupling;
-quantity and quality of oil lubrication needed for the mechanical seal system of the side;
--mixer noise levels (bearing, motor, belt) and environmental background noise;
-temperature of the mixer at the following measuring points: driving unit; bearings; mechanical

seal;
-temperature of the gearbox (if applicable); -vibration levels (amplitudes and frequencies);
-actual absorbed electric motor power during start and normal running conditions for comparison with electric motor performance curves;
-shaft speeds;
-electric motor current readings/variations;
-thrust torque measurement;
-load test of the gear box, if applicable;
-flow in purge and flushing lines of mechanical seals and/or bearings.

7.3. Site tests and Commissioning.
After the side-entry mixer(s) have been installed at site it shall be checked whether the bearings/seal alignment ensures an absolutely liquid-tight operation, and whether the installation has been executed in accordance with the manufacturer's instructions. The site commissioning and performance test run shall consist of a test run at the design conditions for at least 4 hours. Each hour the following observations shall be recorded and compared with figures given by the Manufacturer:
-mixer noise levels (bearing, motor, belt) and environmental background noise;
-temperature of the mixer at the following measuring points: -driving unit; -bearings; -mechanical seal;
-comparison with electric motor performance curves;
-shaft speeds;
-electric motor current readings/variations;
-thrust torque measurement;
-load test of the gear box, if applicable;
-flow in purge and flushing lines of mechanical seals and/or bearings.

8. References
Equipment noise limitation specification (further information latter)
Oil mist lubrication specification (further information latter)
Data/requisition sheet for side-entry mixers (further information latter)
Electrical Motor-cage-induction type (further information latter)
Requisition for electric motors (further information latter)
Protective Coatings (further information latter)
Spare parts (further information latter) .

AMERICAN STANDARDS
AGMA 6010 Standard for spur, helical, herringbone and bevel enclosed drives
API1B Oil-field V-belting
API 610 Centrifugal pumps for general refinery services..
API 650 Welded steel tanks for oil storage
API 677 Special purpose gear units for refinery services.
API 682 Shaft sealing systems for centrifugal and rotary pumps
ASME B16.5 Pipe flanges and flanged fittings
ASME B 16.47 Large diameter steel flanges NPS 26 through NPS 60

ASTM A 609 Ultrasonic examination of carbon and low-alloy steel castings
ASTM E 94 Radiographic testing
ASTM E 186 Heavy walled (51 to 114 mm) steel castings
ASTM E 280 Heavy walled (114 to 305 mm) steel castings
ASTM E 446 Steel castings up to 51 mm in thickness
MSS SP-55 Quality standard for steel castings -visual method.

BRITISH STANDARDS
BS 903: Part A 16 Methods of testing vulcanised rubber Part A16 -Determination of the effect of

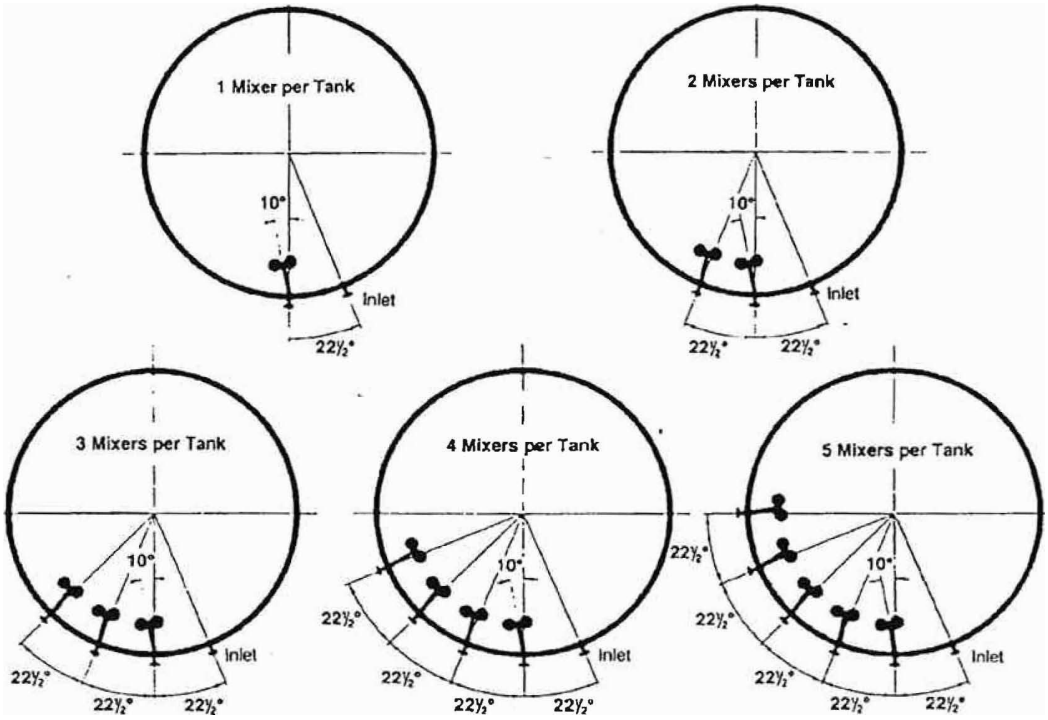
liquids
BS 2050 Electrical resistance of conducting and anti-static products made from flexible polymeric material.
BS 3170 Flexible couplings for power transmission
BS 3790 Endless wedge belt drives and endless V-belt drives.
BS 4548Synchronous belt drives for industrial applications.
BS 5304 Safety of machinery.

IP 15 IP Model Code of Safe Practice: Part 15: Area classification code for petroleum installations

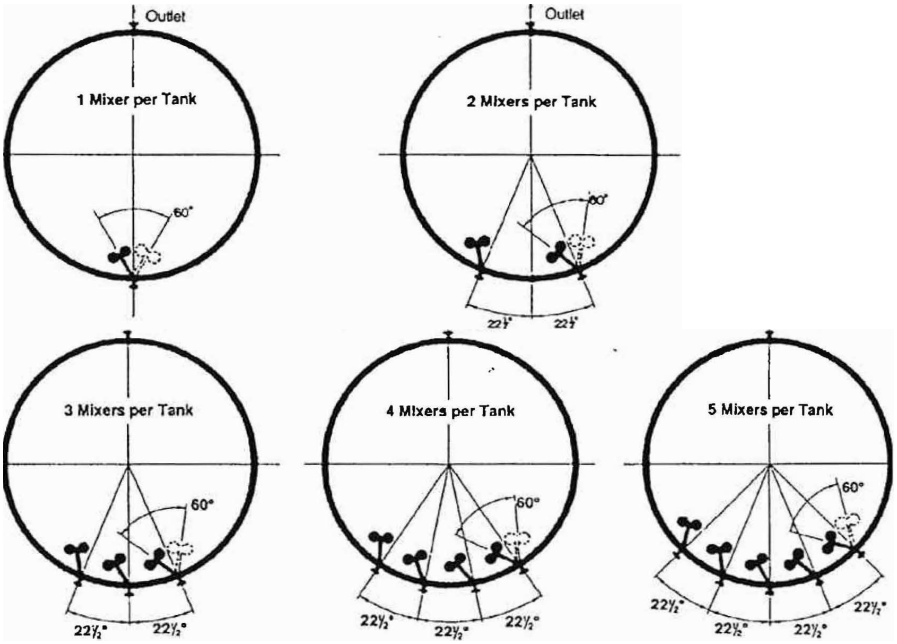
GERMAN STANDARDS
DIN 7753 Endless Narrow V-Belts for Industrial Purposes; Dimensions.
DIN 28155 Flanged couplings for carbon and stainless steel agitators; dimensions.

INTERNATIONAL STANDARDS
lEG 60079-14 Part 14: Electrical installations in hazardous areas (other than mines)
ISO 128 Technical drawings -general principles of presentation
ISO 4184 Belt drives; classical and narrow V-belts; lengths in datum system
ISO 8501-1 Preparation of steel substrates before application of paints and related products Part 1 -Visual assessment of surface cleanliness

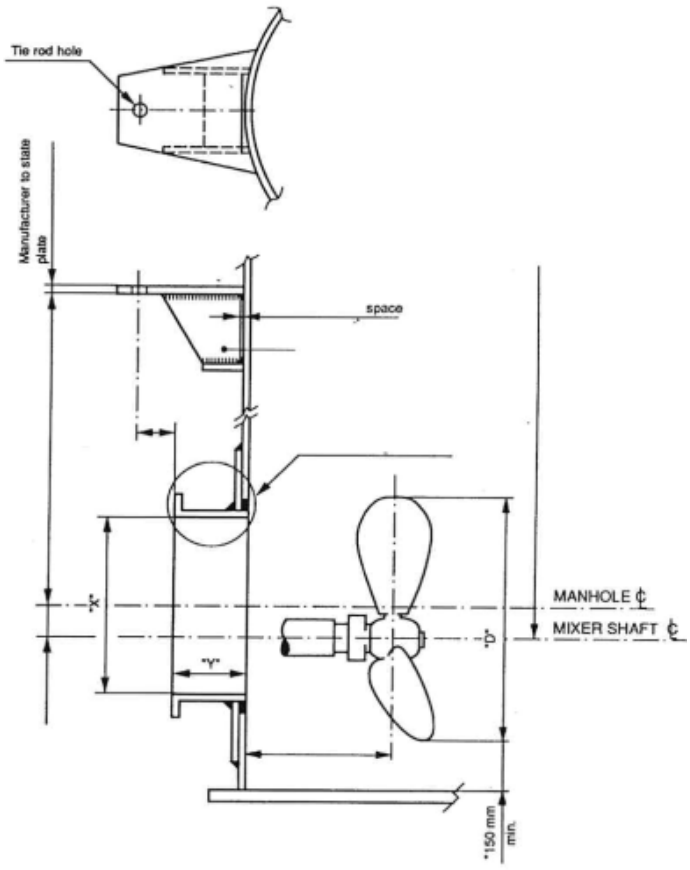
Appendix 1
Recommended Mixer (Fixed-Angle) Positions for Effective Blending, Homogeneity and Temperature Uniformity



Appendix 2
Recommended Mixer (Swivel-Angle) Positions for Effective B.S. And W Control In Crude Oil Tanks



Appendix 3
Storage Tank Side entry Installation



APPENDIX 4
Manhole Mounting Nozzle for Fixed Offset Angle Mixer