

SECTION E - PIPELINES AND PIPEWORK

E1 PIPE AND PIPELINE MATERIALS

E1.1 General Requirements

Pipes, fittings, specials and joints shall be manufactured to the approved national or international Standard and to the additional requirements of this Specification.

All materials and workmanship shall be subject to the general requirements of the General Obligations Section, of this Specification.

Protective coatings and/or linings to be applied at the factory of the pipe manufacturer, or his sub-contractor, are generally specified in this section of the Specification. Coatings and linings to be applied on Site, or highly specialised factory coatings, are specified in Section H, or elsewhere in this Specification.

Design of supports and shop fabrication drawings shall be the responsibility of the Contractor following the indicative locations shown on the drawings or as determined by the pipeline suppliers.

Site tests, cleaning and commissioning are specified in the subsequent INSPECTION, TESTING AND COMMISSIONING Sections.

All pipes in any particular material shall be from a single manufacturing source and of uniform design for the process area to which they apply.

Pipes shall be provided with puddle flanges where they pass through the walls of underground or water retaining structures.

Small bore pipework for sump pumps, vents, etc., may be galvanised steel or copper.

Generally, unless stated otherwise all pipes of 50 mm diameter or above connected to items of plant shall have flanged connections.

All pipes shall be checked for alignment and mating of flanges and connections before being secured. Pipes shall not be sprung into position.

Adequate supporting and anchoring arrangements for all pipes shall be provided and particular care shall be taken to ensure that pipework thrusts are, as far as possible, not transmitted to machinery or other associated plant. Where concrete supports are required, the Contractor shall indicate these on his drawings and the necessary work shall be arranged by the Engineer. The design of the concrete supports shall be the responsibility of the Contractor. The design calculations shall be submitted to the Engineer if requested.

E1.2 Definitions

For the purposes of this Specification, the following definitions shall apply:

"Pipes"-straight pipes with either plain ends or with an integral joint at one or both ends.

"Fittings"-all bends, branches, tees and similar items which are made to the requirements and dimensions in Standard Specifications or are included in manufacturers' standard ranges.

"Specials"-any pipework item which is not covered by Standard Specifications, or is not normally in manufacturers' standard ranges of items, or has any special features which render it different from the standard pipes and fittings.

"Joints"-any joint assembly or components to connect items of pipework together.

E1.3 Pipes and Pipeline Components for Water Supply

Pipes and pipeline components, including their protective coatings and joint materials, that will or may come into contact with potable water shall not constitute a toxic hazard, shall not support microbial growth, shall not cause taste or odour, cloudiness or discolouration of the water, and shall be approved by a recognised certifying authority as being suitable for use in potable water supply systems. Materials in contact with potable water shall be approved by relevant regulatory authorities.

E1.4 Classification of Pressure Pipes

Pressure pipelines shall be those pipelines through which fluid is pumped or which at any point operate under an internal pressure in excess of 3.0 metres head of water.

Pressure pipes shall generally be designated according to their pressure rating. However since national and international standards, procedures and conventions do not all follow the same practice, the pressure ratings established under approved manufacturing standards will not necessarily be accepted as the basis for classification. The pressure ratings which will be adopted for use with this specification will be calculated using the material strengths, allowances and factors of safety indicated in the appropriate pipe material clauses of this specification.

E1.5 Abbreviations and Structural Classification

For structural purposes pipes shall be classified into two groups:

Group A Rigid pipes, which fail ultimately by fracturing, before sustaining unacceptable deformations. Rigid pipe materials include:

Abbreviation	Material
Conc	Concrete (except PTC)
PSC	Prestressed concrete
Clay	Clayware
AC	Asbestos cement

Group B Flexible pipes, which can deform to unacceptable extents without fracture occurring. Flexible pipe materials include:

Abbreviation	Material
PE	Polyethylene
uPVC	Unplasticised polyvinyl chloride
ABS	Acrylonitrile butadiene styrene
RTR (GRP)	Reinforced thermosetting resin/glass reinforced plastic (also relevant to FRP) .
ST	Steel
DI	Ductile iron
PTC	Pretensioned concrete

Notes: (a) ST, DI and PTC pipes often have sufficient strength to support loadings without assistance from the bedding and trench sides but for structural purposes are considered to be flexible.

(b) Polyethylene, uPVC and ABS are further classified as 'thermoplastic' materials.

Group A pipes shall be designated according to their crushing strengths (see Clause E1.13) and Group B pipes according to their stiffness (see Clause E1.14).

GRP pipes have not been specified in the design. The Contractor may propose to use this material for certain processes. Full technical details must be submitted to the Engineer for approval prior to use, proving that they are suitable for use for the fluid and the environment in which they are to be installed. ISO or similar international standards shall apply to the manufacture and physical properties of the pipes and fittings. Refer also to section G regarding details on GRP/RTR.

E1.6 Dimensional Requirements

Unless otherwise indicated in this Section of the Specification, and apart from special lengths of pipe required for flexibility adjacent to structures, pipes may be supplied in any standard lengths allowed in the approved Standard. The tolerance allowed on special lengths shall be ± 25 mm, unless otherwise detailed.

Unless otherwise specified a manufacturing tolerance of ± 2 per cent shall be allowed on the nominal internal diameter of the pipe.

The dimensions and tolerances applying to the jointing surfaces, and sealing rings or gaskets, of pipes, fittings and special shall be such as to ensure that the required sealing performance of the joints is maintained under service conditions, and will not be impaired by normal installation practices.

Pipework dimensions for major process pipework have been provided in the drawings. The Contractor shall confirm these lengths on site based on the civil and structural interface points to ensure correct fit.

The Contractor shall determine the pipe length requirements for the minor process pipework including the chemical dosing plants and miscellaneous water supply.

E1.7 Marking of Pipes and Fittings

Each pipe, special and fitting shall be clearly and indelibly marked at the place of manufacture with:

- (1) The name or distinctive mark of the manufacturer.
- (2) The date of manufacture.
- (3) The class or pressure rating.
- (4) The nominal diameter.
- (5) The manufacturing standard to which it has been produced.
- (6) For rigid pipes - crushing strength (in kN/m or strength class).
- (7) For flexible pipes - stiffness (in N/m²).
- (8) The angle of bends or branches.
- (9) The name of the Employer and the Project or Contract.
- (10) Where appropriate the pipework item reference number.

E1.8 Copper Tubes and Fittings

Copper tubes shall be to ISO 1635 all fittings shall be compression type.

E1.9 Galvanised Steel Pipework

Steel pipes shall comply with ISO 65: heavy, fittings shall be in accordance with ISO 49, and shall be galvanised to ISO 1459, 1460, 1461.

Steel pipes of 50 mm bore and below may be supplied with screwed and socketed joints. All other joints shall be made with screwed on NP25 flanges. The screwed on flanges and joints shall be made and protected with zinc chromate paste.

E1.10 Chemical Pipes and Hoses

Chemical pipes and hoses shall be of non-flame propagating materials suitable for the chemicals in use and shall be supplied in duplicate. They shall be arranged for easy dismantling for cleaning where appropriate, and if screwed joints or joints formed by solvent welding are proposed for any chemical line, a sufficient number of flanged or flexible joints shall be provided to enable the pipework to be removed in sections without working from one end to the other of a particular run. Tees and cocks shall also be provided at convenient points for the connection of a pressure water supply to flush pipework through as required.

All chemical pipes and hoses shall be banded to enable individual lines to be identified throughout their run. Wherever possible racks or trays shall be fixed to duct walls or walls of tanks and buildings, and the chemical pipes shall be fixed to these racks or trays with clips which can easily be removed without dismantling adjacent pipes. The Contract includes for the supply and fixing of all such racks or trays. Full details of the type of hoses, pipes, and racks or trays proposed, shall be supplied for approval by the Engineer.

E1.11 to E1.13 Not Used

E1.14 Stiffness for Group B (Flexible) Pipes

Pipes for non-pressure purposes shall have minimum specific tangential initial stiffness, at the ambient temperature stated in Clause A2.2 or at 20°C where no such temperature is stated, in accordance with one of the following classes:

Class L1	1 250N/m ²
Class L2	2 500N/m ²
Class M	5 000N/m ²
Class H	10 000N/m ²

The initial stiffness of pipes having diameter of 500mm or more, shall not exceed the minimum stiffness value of the next higher class.

Stiffness shall be calculated as EI/D^3 , where E is the modulus of elasticity of the pipe wall material in ring bending, I the moment of inertia per unit length of pipe wall in ring bending and D the mean diameter of the pipe.

Pipes for pressure pipelines shall have stiffnesses at least corresponding to Class L1.

E1.15 Thermoplastic Pipes

(1) General Requirements

Thermoplastic pipe materials include polyethylene, uPVC, ABS, PP and PB.

The only additives which may be used during pipe manufacture are those which are necessary for the manufacture of the basic polymer feedstock and for its satisfactory further processing to produce a finished product complying with the Specification. All additives shall be thoroughly dispersed throughout the material. Thermoplastic components shall be stabilised against ultra-violet light degradation. The material shall be thoroughly and consistently fused throughout the component.

Unless otherwise specified, polyethylene, polypropylene and polybutylene pipes shall be jointed by fusion welding in accordance with Clause E3.3.6, and uPVC and ABS pipes shall be jointed using integral sockets and spigots, in accordance with Clause E1.25.

Solvent-welded joints shall not be used except where shown on the drawings or agreed by the Engineer.

Compliance with the appropriate stiffness class of Clause E1.14 shall be verified by parallel plate loading tests in accordance with Clause E2.4, carried out at the ambient temperature stipulated in Section A, or at 20°C where no such temperature is stipulated.

The hoop tensile strength of the material shall be obtained by stress rupture testing in accordance with Clause E2.4 and the estimated minimum hoop tensile strength at 50 years, obtained by extrapolation of the test results shall be in accordance with the following table:

Minimum 50 Year Hoop Tensile Strength for Thermoplastic Group B Pipes

Material	Hydrostatic Design Stress @ 20°C (MPa)	Temperature Derating Factors			
		25°C	30°C	35°C	40°C

PVC-U	12.5	1.0	0.88	0.78	0.70
PE/MRS 100	6.3	0.9	0.81	0.72	0.62
PE/MRS 80	6.3	0.9	0.81	0.72	0.62
PE/MRS 63	5.0	0.9	0.81	0.72	0.62
PE/MRS 40	2.5	0.82	0.65	0.47	0.30
PE/MRS 32	2.0	0.82	0.65	0.47	0.30

The pressure ratings of the pipes, as defined in Clause E1.4, shall be obtained by using the hydrostatic design stress from the above table, and applying the derating factor appropriate to the design temperature as specified in the particular specification.

The finish of pipes shall comply with the requirements of Clause E1.4.

(2) **Polyethylene Plastics**

Copolymerisation with small quantities of propylene is permitted. The specific gravities of polyethylene plastics shall be in the following ranges: low density 0.710 to 0.925, medium density 0.926 to 0.950, high density 0.951 and over.

Polyethylene pipes shall be jointed by fusion welding in accordance with Clause E3.6, unless otherwise specified.

(3) **uPVC Plastics**

uPVC pipework shall be generally in accordance with ISO 4422, for potable water, ISO 3633 or ISO 4435. The minimum pressure rating shall be Class C. For chemical systems a minimum rating 15 bar shall be used.

PVC material shall be unplasticised and of an impact resistant or high impact grade. High molecular orientation uPVC may be used. The material shall have a fracture toughness of not less than $3.25 \text{ MN/m}^{3/2}$.

PVC pipes for general drainage service shall be provided with socket and spigot joints, sealed by elastomeric sealing rings, unless otherwise specified. PVC pipes used for process service shall be solvent welded, with screwed union joints used for valves and other equipment to allow for removal for maintenance. The number of mechanical joints shall be agreed with the Engineer.

Process pipework shall be colour coded and labelled if installed indoors and painted with solar resistant (UV) paint and labelled if installed externally. Manufacturer's recommended installation guidelines shall be followed as well as use of correct solvents as recommended by the manufacturer of the pipe. The same manufacturer shall be used to supply both pipes, valves and fittings for each stand alone process or system.

Where mechanical joints are required to restrain external thrust loads, flange type joints shall be used. Flanged joints shall be stub flanges with metal backing rings. The flanged joints shall meet the requirements of ISO 2536 and ISO 3460.

The extrapolated long term hydrostatic failure pressures at 1 hour and 50 years shall be respectively not less than 3.6 times and not less than 2.1 times the working pressure of the joint or fitting.

Joints, whilst deformed to 7.5% reduction in diameter, shall withstand a pressure of $25 \pm 3 \text{ kN/m}^2$ below atmospheric pressure for 1 hour without leakage.

All flanges shall be drilled to suit ISO 7005: NP16 unless the flange is to be jointed to an existing item of plant which is drilled otherwise. In this case the flange shall be drilled to suit.

(4) ABS Plastics

ABS plastics may be either copolymers of, or blends of homopolymers of, the constituent monomers. The maximum content of acrylonitrile shall be 15%, of butadiene shall be 6% and of styrene (or substituted styrene) shall be 15%. The total content of the three basic monomeric constituents shall be not less than 95% and the specific gravity shall be in the range 0.990 to 1.200.

ABS pipes shall be provided with socket and spigot joints, sealed with elastomeric sealing rings, unless otherwise specified. ABS pipes used for process service shall be solvent welded, with screwed union joints used for valves and other equipment to allow for removal for maintenance. Process pipework shall be colour coded and labelled if installed indoors and painted with solar resistant (UV) paint and labelled if installed externally. Manufacturer's recommended installation guidelines shall be followed as well as use of correct solvents as recommended by the manufacturer of the pipe. The same manufacturer shall be used to supply both pipes, valves and fittings for each stand alone process or system.

E1.16 High Density Polyethylene Pipes

This Material Specification details the minimum requirements for the design, manufacture, testing, inspection and supply of High Density Polyethylene (HDPE) or High Performance Polyethylene (HPPE) pipe material and fittings to be used for transport and distribution of potable water.

(1) Applicable Standards And Codes

The following codes and standards, to the extent specified herein, form a part of this specification. The latest edition of these codes and standards shall govern the work.

ISO 4427	Polyethylene (PE) pipes for water supply – specifications
ISO 161-1	Thermoplastic pipes for conveyance of fluids – nominal outside diameter and nominal pressure- part 1: Metric series
ISO 1167	Thermoplastic pipes for the conveyance of fluids – Resistance to internal pressure – Test Method
ISO 3126	Plastic pipes – Measurement of dimensions
ISO 4065	Thermoplastic pipes – Universal wall thickness table

ISO 6964	Polyolefin pipes and fittings – Determination of carbon black content by calcination and pyrolysis – Test method and basic specification.
ISO 9080	Thermoplastic pipes for the transport of fluids – Method of extrapolation of hydrostatic stress rupture data to determine the long-term hydrostatic strength of thermoplastic pipe materials.
ISO 11922-1	Thermoplastic pipes for the conveyance of fluids – Dimensions and tolerances Part: 1: Metric series.
ISO 12162	Thermoplastic materials for pipes and fittings for pressure applications – Classification and designation – overall service (design) coefficient.
ISO 13761	Plastic pipes and fittings – pressure reduction factors for polyethylene pipeline systems for use at temperatures above 200 C.
ISO 7005	3 Metallic flanges – Part 3, Copper alloy and composite flanges
PR EN 12201	Plastic piping systems for water supply – polyethylene

(2) **Material Requirements**

The CONTRACTOR shall identify the manufacturer of the resin, the resin type and classification. In addition, the CONTRACTOR shall provide evidence that the resin proposed is suitable for use at the design temperature and under the design pressures indicated.

Any change in the material, the material specification, or the manufacturer's location shall be subject to prior approval of the ENGINEER.

Pipes and fittings shall be homogenous throughout and free from visible cracks, holes, foreign inclusions, blisters, dents or other damaging defects. Joints are not acceptable.

Material shall be uniform in opacity, density, interior smoothness, and other physical properties. It shall have adequate resistance to weathering and other ageing from outside storage for a minimum of two years after manufacture.

The material of the polyethylene pipes and fittings which is in contact with or likely to come in contact with drinking water shall not constitute a toxic hazard, shall not support microbial growth and shall not give rise to unpleasant taste or odour, cloudiness or discoloration of the water. Materials in contact with potable water shall be approved by relevant regulatory authorities.

The concentration of substances, chemical and biological agents leached from materials in contact with drinking water, and measurement of the relevant organoleptic / physical parameters, shall not exceed the maximum values recommended by the World Health Organisation in its "Guidelines for Drinking Water Quality" or the EEC Council Directive on the "Quality of Water Intended for Human Consumption", whichever is more stringent in each case.

If rework material is added or used, it shall be clean, derived from the same resin and reground under the supervision of the same manufacturer and shall be compatible with the material to which it is added.

The pipes and fittings shall be manufactured from polyethylene containing only those antioxidants, UV stabilisers and pigments necessary for the manufacturing of the pipes and confirming to the requirements of ENGINEER and the specification.

All pipes and fittings shall be suitable for butt fusion or electro fusion welding techniques.

(3) Physical Properties

Polyethylene pipes and fittings shall be high density polyethylene pipes (HDPE) and shall comply with the requirements of ISO 4427 type PE 100.

The minimum required strength (MRS) of the material compound shall be 10 MPa at 20⁰ C and 50 years life time. The design stress shall be 8 MPa.

The polyethylene pipes and fittings shall meet the following specification:

- Minimum density measured according to ISO 1872 > 959 Kg/m³.
- Melt flow rate measured according to ISO 1133 - at 2.16 kg load < 0.15g/10min.
 - at 5.0 kg load < 0.5 g / 10 min.
- Tensile strength at yield = 23 MPa.
- Elongation at break at > 600%.
- Thermal conductivity at = 0.4 W/m⁰ K.
- Vicat softening point at 1 kg load = 124⁰ C.

The thermal stability of polyethylene material shall meet the requirements of ISO 4427.

(4) Pipe Dimensions

The pipe dimensions, which are based on standard dimensions ratio 11 (SDR 11) are specified in the following Table.

Nominal Outside Diameter (mm)	Mean Outside Diameter (mm)		Wall Thickness (mm)	
	Minimum	Maximum	Minimum	Maximum
90	90.0	90.6	8.2	9.2
110	110.0	110.7	10.0	11.2
180	180.0	181.2	16.4	18.2
250	250.0	251.5	22.7	25.2
315	315.0	316.9	28.6	31.7
355	355.0	357.2	32.2	35.7
500	500.00	503.0	45.5	50.3
630	630.0	633.8	57.2	63.1

Straight pipe shall be supplied in standard lengths of 11.8 m (-0 + 150 mm) measured at 23⁰ C ± 20 C. Unless otherwise specified, coil lengths shall not

exceed 100 m. The coils shall be wrapped and shall not be exposed to direct sunlight.

(5) Pipe Appearance

All polyethylene pipes to be used for the transport and distribution of potable water shall be black and have blue coloured markings.

The carbon black content in the compound shall be 2.25 ± 0.25 % by mass when measured in accordance with ISO 6964. The dispersion of carbon black when determined in accordance with ISO 11420 shall be equal to or less than grade 3.

(6) Fittings

The fittings shall be injection moulded or formed from material compatible to that of the pipe. At locations where HDPE to metal connections are specified, stub flanges with Rilsan coated backing rings shall be used, or special restrained transition fittings approved by the ENGINEER. The flanges shall be drilled to ISO 7005-2, PN 10 or PN 16 as per the design requirements.

(7) Inspection And Testing

(a) Certification and Documentation

An authority appointed by the Employer shall certify all items supplied to this Specification. The MANUFACTURER shall document and certify all products and required tests and CONTRACTOR shall supply the ENGINEER with copies of these certifications and test documents. Such documentation shall be subject to ENGINEER's approval prior to shipping.

All items shall comply with the requirements of ISO 4427 and any additional requirements listed in this specification.

(b) Test Results and Frequencies

The MANUFACTURER shall establish and maintain a current record of test results according to the requirements of the applicable standards and this specification. The MANUFACTURER shall perform all the tests required by ISO 4427 to demonstrate the characteristics and quality of the resin material and the dimensional tolerances of the pipe. The MANUFACTURER shall document all the tests, with frequencies and results as indicated in ISO 4427.

Notes: For establishing test frequencies:

- Coil and straight lengths are as noted in clause iv;
- Straight length pipe shall be tested at the same frequency as coiled pipe;

- A continuous production run is the manufacture of pipe of one resin type, size, and wall thickness, for one purchase, with no interruption or change in the manufacturing process.

The CONTRACTOR/MANUFACTURER shall supply the ENGINEER, with copies of all material certificates and inspection and test results obtained in the course of quality verification. When requested, the MANUFACTURER shall also provide access to and copies of all production record, process control charts, and other records compiled during manufacture.

(c) Inspection and Audit Requirements

Pipe shall comply fully with ISO 4427 and all the additional requirements of this specification.

To verify compliance with this specification, the ENGINEER shall appoint an independent third party inspector to witness the applicable qualification tests, review production records, and inspect general handling and shipping procedures. The CONTRACTOR/MANUFACTURER shall give 7 days notice of its intent to begin production to allow the ENGINEER to arrange for third party inspection. The third party inspector shall have full access to the testing and production facilities and will be a fully authorized representative of the ENGINEER.

(d) Acceptance Criteria

The order shall meet the following criteria:

A copy of the raw material MANUFACTURER's "Certificate of Quality Control Testing" covering each batch of raw material used for pipes purchased under this specification, shall be available for inspection by the ENGINEER on request.

Pipe wall thickness shall be controlled by continuous scanning using gamma ray or other qualified devices. These devices shall be regularly calibrated for accuracy.

Successful test performance and acceptable results for the testing program outlined in this specification.

An acceptable inspection report from a third party inspection company (at the option of the ENGINEER).

When performed, acceptable results from an independent test audit of any portion of the tests noted in ISO 4427 and this specification.

The ENGINEER may reject any item that does not fully comply with the requirements of this specification.

(e) Defects

When the rejected item is a length or coil of pipe, the lengths or coils manufactured immediately before and after the defective lengths or coils shall be carefully examined. If further defects are found, this is sufficient cause for rejecting the entire batch. This will not apply to local damage that did not occur during manufacture, such as gouges or cuts during handling or transit.

(8) Quality Assurance/Quality Control

A copy of the MANUFACTURER's QA/QC program shall be submitted to ENGINEER with its quotation for review and concurrence prior to award. If MANUFACTURER's facility is ISO certified, QA audit requirements will be waived in favour of ISO 9000 registrar audits, unless the ENGINEER's trend analysis program indicates areas of concern.

(9) Packing, Marking And Vendor Documentation

(a) Pipe Identification

The marking information and sequence shall comply with ISO 4427 and this specification. All pipes and fittings, including test samples shall be clearly and permanently marked using indent printing in a colour that contrasts with the pipe.

- All marking shall be repeated at least every 1.0 m and shall be displayed on the outside of the coil/length together with the following information:
 - MANUFACTURER's name or trademark
 - resin name or type (to be proposed and subject to prior ENGINEER's approval)
 - the letters "PE" followed by the PE grade (e.g. PE100)
 - the service, i.e. the word "Water" for water pipelines (blue marked)
 - the nominal outside diameter (NOD) in millimetres (mm)
 - standard dimension ration
 - coil/length number
 - plant location and date of manufacture, e.g. X 29 08 00, where X designates the plant
 - the letter "R" if regrind material was used
 - production information, e.g. 251Y, where 2 indicates shift, 5 indicates operator, 1 indicates extruder, and Y indicates compound supplier
- The maximum quantity of pipe to have the same coil/length number is one silo (coiled pipe) or one bundle (straight lengths). The maximum combined length of pipe in the silo or bundle with the same coil/length number shall not exceed the maximum allowable coil length specified in clause 2.2.
- When pipe material is boxed, the coil number shall be clearly marked on the outside edge of the box or silo. Invoices and packing lists shall include the date of manufacture and coil/length numbers for all material in the shipment.

(b) Shipping

The CONTRACTOR/SUPPLIER shall provide packing and shipping procedures for approval by the ENGINEER and shall comply with the following requirements.

(c) Delivery

Delivery of the plastic pipes and fittings to site, shall be no later than six months after the stamped manufacture date, for it to be acceptable.

Pipes boxed immediately after extrusion and stored indoors, as well as pipes protected from UV light immediately after manufacture as per the requirements of clause ix.4, are - at the ENGINEER's discretion - exempt from this requirement and are acceptable up to one year after manufacture.

(d) UV Protection

To obtain this exemption (from clause ix.3), the CONTRACTOR/MANUFACTURER shall inform the ENGINEER one month prior to manufacture for inspection and approval of the protective method. All silos of coiled pipe shall be shrink-wrapped in UV-blocking black plastic. The black plastic shall be thick enough to prevent accidental tearing and passage of visible light. The UV-blocking plastic wrap shall filter out 100% of the UV radiation from reaching any portion of the PE pipe. IF the plastic is not black, the MANUFACTURER shall receive prior approval from the ENGINEER before the wrap is used. Approval of non-black shrink wrap plastic may involve testing. The cost of this testing shall be to the account of the CONTRACTOR/MANUFACTURER.

(e) Tie-Downs

Tie-downs shall be at least 100 mm wide and be clean and free from sand, gravel and other such materials. For straight length pipe (up to 12 m), a minimum of 6 tie-downs are required.

(f) Pallets

The pallets shall be suitable for transporting the material from the place of manufacture to the designated receiving location without causing any damage to the pipe. The pallets shall not contain any broken planks or extremities that may damage the coiled pipe or straight lengths. They shall be durable enough to prevent loose pallet nails from gouging the bottom coil/straight length. Pallet construction shall be subject to approval by the ENGINEER.

(g) Overhang

Pipe shall not overhang at either end of the trailer.

(h) Stacking

The CONTRACTOR/MANUFACTURER shall not ship small coils stacked inside silos of larger coils. Frames manufactured for the containment of straight lengths of polyethylene pipe during transport and storage shall not contain nails or other fastening devices that may damage the pipe.

(i) Trucking

Where pipes are transported by vehicles, the vehicles should have a flat bed and be free from sharp edges or projections. During transport, polyethylene pipes shall be protected from diesel fumes and be continuously supported to prevent movement between the material and its support.

(j) Silo's

Silo packs of coiled pipes shall be squarely stacked and well supported on pallets. Coils shall not overhang the pallets and, unless approved by the ENGINEER, shall not be stacked higher than 2.3 m.

(k) Banding

All coils shall be banded at intermediate stages of coiling and upon completion of the specified length. At least 8 intermediate bands shall be provided on 150 m coils.

(l) End Caps

Straight lengths and coils of pipe shall have internally fitted end caps that prevent dirt and debris from entering the pipe during handling, storage and transport. Caps shall be attached by an approved method to prevent the accidental loss of the cap. All end caps shall have an outer lip, which prevents the accidental insertion of the cap into the pipe. A method to permit venting shall be provided in order to allow expansion of air due to temperature changes during storage.

(m) Vendor Documentation

The CONTRACTOR shall furnish following vendor data as a minimum, with the bid:

Catalogues/Brochures.

- Dimensional details of pipes and fittings.
- Detailed material specifications.
- Manufacturer's drawings.
- Complete details of testing facilities available at manufacturer's works.
- Local (Iraq) agent name and address.

Bids not accompanied by any of above mentioned information/data shall be considered incomplete, and liable to be rejected.