SERIES 9000: ANCILLARY WORKS

TABLE OF CONTENT

TABLES AND FIGURES **6**

DIVISION 9100: GABIONS **7**

9101 Scope 7
9102 Materials 7
(a) Rock 7
(b) Wire 7
(c) Galvanizing 7
(d) Wire Mesh and Clip Fasteners 8
(e) Geotextile Filter Fabric 9
9103 Construction Of Gabion Cages 9
(a) General 9
(b) Selvedges 10
(c) Diaphragms and End-panels 10
(d) Binding and Connecting Wire 10
(e) Tolerances 10
(f) Unit Weight Requirements and Test 10
9104 Construction Of Gabions 11
(a) Preparation of the Foundation and Surface for Bedding 11
(b) Assembly 11
(c) Rockfilling 11
(d) Gabions using PVC Coated Wire 11
9105 Measurement And Payment 12
Item 91.01 Foundation trench excavation and backfilling 12
Item 91.02 Surface preparation for bedding of gabions 12
Item 91.03 Gabions 12
Item 91.04 Filter fabric 12

DIVISION 9200 : DELINEATORS, MARKERS AND KILOMETRE POSTS **13**

9201 Scope 13
9202 Materials 13
(a) Flexible Delineators, Markers, and Kilometers Posts 13
(b) Concrete Posts 15
9203 Manufacturing: Concrete Posts 15
9204 Spacing Of Posts 15
9205 Erection 15
(a) Ground Mounted Flexible Units 15
(b) Guide Rail Mounted Flexible Units 15
(c) Barrier Curb Mounted Flexible Units 16
(d) Concrete Posts 16
9206 Measurement And Payment 16
Item 92.01 Delineators, markers and kilometer posts 16

DIVISION 9300: GUARDRAILS 18

9301 Scope 18
9302 Materials 18
(a) Guardrails 18
(b) Guardrail Posts 18
9303 Erection 19
9304 Requirements 19
9305 Measurement And Payment 20
Item 93.01 Guardrails on posts 20
Item 93.02 End units and miter units 20

DIVISION 9400: ROAD SIGNS 21

9401 Scope 21
9402 Materials 21
(a) Structural Steel 21
(b) Aluminum 21
(c) Bolts, Nuts and Rivets 21
(d) Steel Plate 22
(e) Particle Board 22
(f) Concrete 22
(g) Fiberglass 22
(h) Retro-Reflective Material 23
(i) Paint 23
(j) Corrosion Protection Tape 23
9403 Manufacturing Of Road Sign Faces And Supports 23
(a) Road Sign Faces 23
(b) Welding 24
(c) Aluminum Extrusions 24
(d) Galvanizing 24
9404 Painting 24
(a) Colors, Symbols and Legend 24
(b) Preparation of Surfaces and Application of Paint 25
(c) Time of Painting 25
(d) Painting of concrete 25
9405 Storage And Handling 25
9406 Erection Of Road Signs 25
(a) Position 25
(b) Excavation and Backfilling 26
(c) Erection 26
(d) Field Welding 26
(e) On Site Painting 26
(f) Time of Erection 26
9407 Protection And Maintenance 26
9408 Dismantling, Storing And Re-Erecting Existing Road Signs 26
9409 Measurement And Payment 27
Item 94.01 Sign faces with painted background. Symbols, lettering and borders in Engineering grade retro-reflective material with signboard 27
Item 94.02 Sign supports 27
Item 94.03 Concrete in road sign footings including excavation and backfilling 27
Item 94.04 Dismantling, storing and re-erecting road signs 27

Item 94.05 Dismantling and storing road signs 28

DIVISION 9500: ROAD TRAFFIC MARKINGS AND ROAD STUDS 29

9501 Scope 29
9502 Materials 29
(a) Road-Marking Paint 29
(b) Retro-reflective road-marking paint 29
(c) Thermoplastic road-marking material 29
(d) Color 29
9503 Weather Limitations 29
9504 Mechanical Equipment For Painting 29
9505 Surface Preparation 30
9506 Setting Out Of Road Traffic Markings 30
9507 Application Of Paint 30
9508 Application Of Retro-Reflective Beads 31
9509 Road Studs 31
9510 Tolerance Requirements 31
(a) Width 31
(b) Position 31
(c) Alignment of Markings 32
(d) Broken Lines 32
9511 General 32
9512 Faulty Workmanship Or Materials 32
9513 Protection 32
9514 Measurement And Payment 32
Item 95.01 Paint (specify road marking, retro-reflective road marking and/or Thermoplastic) 32
Item 95.02 Variation in rate of application 33
Item 95.03 Roadstuds 33

DIVISION 9600: LANDSCAPING AND GRASSING 34

9601 Scope 34
9602 Materials 34
(a) Fertilizer 34
(b) Grass Cuttings 34
(c) Grass Seed 34
(d) Topsoil 34
9603 Landscaping The Areas 35
(a) Shaping 35
(b) Trimming 35
9604 Preparation Of Areas For Grassing 35
9605 Grassing 35
(a) Planting of Grass Cuttings 35
(b) Seeding 36
(c) Topsoiling only 36
(d) The grassing of borrow pits, temporary deviations, camp sites, access roads and stockpile sites 36
9606 Establishment And Maintenance Of The Grass 36
(a) Watering, Weeding, Cutting and Replanting 36
(b) Acceptable Cover 37

(c) Maintenance Period 37
9607 General 37
(a) Time of Planting 37
(b) Traffic on Grassed Areas 37
(c) Erosion Control 37
(d) Responsibility for Establishing an Acceptable Cover 37
9608 Measurement And Payment 38
Item 96.01 Stockpiling of Topsoil 38
Item 96.02 Preparation of areas for grassing 38
Item 96.03 Grassing 38

DIVISION 9700: PAINTING OF STEEL 40

9701 Scope 40
9702 General. 40
(a) Specifications 40
(b) Paint formula 40
9703 Surface Preparation-General Requirements 41
9704 Surface Preparation-Materials And Methods 42
9705 Procedures For Treatment At Areas Of Mechanical Damage Or Other Surface Defects 42
9706 Procedures For Treatment Of Local Failure In Protective coatings 43
9707 Workmanship Standards For The Surface Preparation Of Steel By Blast Cleaning, Abrading, Grinding And Cleaning 43
9708 Paint And Similar protective coatings 44
9709 Storage Requirements And Keeping Periods For Paints 44
9710 Application Of Paint 44
9711 Procedure Trials 45
9712 Measurement And Payment 46
Item 97.01 Preparation of steelwork prior to coating 46
Item 97.02 Protective system to steelwork 46

DIVISION 9800: FENCING 47

9801 Scope 47
9802 Materials 47
(a) Posts, strays, standards and droppers 47
(b) Bolts for strays 47
(c) Barbed wire 47
(d) Gates 47
(e) Timber posts 48
(f) Manufacturing tolerances for wire 48
9803 Types Of Fencing 48
9804 Protection Of Livestock 48
9805 Clearing Of Fence Line 48
9806 Installing Posts And Standards 49
9807 Installing Wire 49
9808 Closing Openings Under Fences 49
9809 Existing Fences 50
9810 Installing Gates 50
9811 General Requirements 50
9812 Measurement And Payment 50
Item 98.01 Fencing 50

Item 98.02 New gate (size and type indicated).....50
Item 98.03 Moving of existing fences and gates 51

TABLES AND FIGURES

Table 9102-1 Rock size 7
Table 9102-2 Coating of wire 8
Table 9102-3 Mesh size 8
Table 9102-4 Physical Requirements for Geotextile 9
Table 9103-1 Standard sizes of boxes and mattresses 10

DIVISION 9100: GABIONS

9101 SCOPE

This Division covers the construction of gabion walls and aprons for the construction of retaining walls, lining of channels, revetments, and other anti-erosion structures in accordance with the details shown in the Contract.

9102 MATERIALS

(a) Rock

Stones or rock for filling gabions shall be obtained from sources located by the Contractor and approved by the Engineer.

Rocks used as filling for cages shall be clean, hard, sound, durable and unweathered boulders or rock fragments.

No rock particles shall exceed the maximum size given below and at least 85% of the rocks shall have a size equal to or above minimum size given in Table 9102-1 below:

Table 9102-1 Rock size

Depth of cage (mm)	Minimum (mm)	Maximum (mm)
0.2	75*,95**	125
0.3	100	200
0.5	100	250
1.0	100	300

* Using 60 x 80 mm mesh

**Using 80 x 100 mm mesh

(b) Wire

All wire used in the fabrication of the gabions and in the wire operations during construction shall be to ASTM A 910, Grade # 1010 or 1015 or to BS 1052, having a tensile strength of not less than 350 MPa.

Cold drawn steel wire fabric shall meet the requirements of AASHTO M 55.

(c) Galvanizing

All wire used in the fabrication of gabions shall be galvanized in accordance with the provisions of ASTM A 641 with Class 3 coating or aluminized with a coating weight per ASTM A 809 or BS 729 for Class A heavy galvanized mild steel wire.

The minimum mass of the zinc- coating shall be according to the figures shown in Table 9102-2 below:

Table 9102-2 Coating of wire

Nominal diameter of coated wire (mm)	Mass of coating (g/m^2 surface area)
3.7-4.0	290
3.0-3.6	275
2.2-2.9	260
below 2.2	245

The adhesion of the zinc coating to the wire shall be such that when the wire is wrapped six turns round a mandrel of four times the diameter of the wire, it shall not flake nor crack to such an extent that any zinc can be removed by rubbing with bare fingers.

(d) Wire Mesh and Clip Fasteners

Wire mesh shall be hexagonal-woven mesh wherein the joints are formed by twisting each pair of wires through three half turns.

The tightness of the twisted joints shall be such that a force of not less than 1.7 kN is required when pulling on one wire in order to separate it from the other wire provided each wire is prevented from turning and the applied forces and the wire are all kept in the same plane.

The diameter of the wire and the size of mesh used shall be as shown in Table 9102-3 below:

Table 9102-3 Mesh size

Depth of gabion (m)	Mesh size (mm)	Wire diameter (mm)
0.5 and over	80x100 100x120	2.5 2.7
0.2 -0.3	80x100 60x80	2.2 2.0

The shorter dimensions of the mesh shall be taken from center to center of the twisted joints, and the larger dimensions shall be between the inside ends of twisted joints

OR; Wire used in the body of the mesh shall not be thinner than 11 gage for galvanized baskets and 12 gage for PVC coated baskets. Selvage wire shall not be less than 10 gage, and lacing and tie wire shall not be thinner than 13 gage.

Clip fasteners shall be galvanized and/or PVC coated as required and may be of any type that provides positive lock when installed. They shall be stronger than the mesh to which they are attached.

Galvanizing on the steel clips shall be in accordance with ASTM A 641 with a Class 3 coating, and aluminizing shall be in accordance with ASTM A 809.

(e) Geotextile Filter Fabric

Where indicated on the drawings or ordered by the Engineer, one layer of approved geotextile material shall be placed on the prepared surface prior to the placing of gabions.

The material shall be placed as directed in vertical strips with a minimum overlap of 300 mm, and shall be properly fastened to prevent any movement or slipping during the placing of gabions.

The geotextile shall meet the requirements given in Table 9102-4 below:

Table 9102-4 Physical Requirements for Geotextile

Property	Test Method ASTM	Units	Specifications[1]
Grab Strength	D 4632	N	1400/900
Sewn Seam Strength	D 4632	N	1260/810
Tear Strength	D 4533	N	500/350
Puncture Strength	D 4833	N	500/3500
Burst Strength	D 3786	kPa	3500/1700
Permittivity	D 4491	s^{-1}	0.02
Apparent Size Opening	D 4791	mm	0.60[2]
Ultraviolet Stability	D 4355	%	50%[3]

(1) The first values apply to geotextiles that break at <50 percent elongation (ASTM D 4632). The second values apply to geotextiles that break at >/=50 percent elongation (ASTM D 4632).

(2) Maximum average rolls value.

(3) After 500 hours of exposure

9103 CONSTRUCTION OF GABION CAGES

(a) General

Gabions shall consist of woven steel mesh boxes or mattresses filled with stones.

Gabion panels shall be either proprietary manufacture or woven on site as described in the Contract.

Gabion cages shall be fabricated of wire mesh of the size and type and selvedge as specified below. The cages shall be sub- divided into cells by wire mesh diaphragms and will be of two types:

Boxes, which are generally used for the construction of gabion walls. Boxes are sub-divided into cells by diaphragms spaced at 1.0 m intervals.

Mattresses, in which the maximum width shall be 2.0 m, the maximum depth shall be 0.5 m. Mattresses shall be sub-divided by diaphragms into cells having a width of 500 mm or 1.0 m as specified.

Standard sizes of boxes and mattresses are given in Table 9103-1 below:

Table 9103-1 Standard sizes of boxes and mattresses

Dimensions	Boxes	Mattresses:
Lengths:	1,2,3,4 and 6 meters	6m
Widths:	1 m	2m
Depths:	0.3 m, 0.5 m, and 1.0 m	0.2 m, 0.3 m, and 0.5 m
Diaphragm spacing:	1.0 meter	500 mm or 1.0 m as directed

Other gabions may be supplied, provided the Engineer's approval is obtained beforehand.

(b) Selvedges

The cut edges of all mesh used in the construction of gabions, except the bottom edge of diaphragms and end panels, shall be selvedged with wire of at least twice the diameter of the mesh wire diameter.

Where the selvedge is not woven integrally with the mesh but has to be fastened to the cut ends of the mesh, it must be attached by binding the cut ends of the mesh about it so that a force of not less than 8.5 kN applied in the same plane as the mesh, at a point on the selvedge of a mesh sample 1 m long, is required to separate it from the mesh.

(c) Diaphragms and End-panels

The diaphragms and end-panels shall be selvedged on the top and vertical sides only.

The end-panels shall be attached by twisting the cut ends of the mesh wires at the bottom of the panel about the selvedge on the base of gabions. Similarly, the diaphragms shall be attached by twisting the cut ends of the mesh to the twisted joints of the mesh of the base of the gabion. In each case the force required to separate the panels from the base should not be less than that required to break the mesh over the same length.

(d) Binding and Connecting Wire

Sufficient binding and connecting wire must be supplied with the gabion cages to perform all the wiring operations to be carried out in the construction of the gabion work specified in Clause 9104 below.

The diameter of wire shall be 2.0 mm.

(e) Tolerances

A tolerance on the specified diameters of all wire of 2% shall be permitted.

The length of the cages is subject to a tolerance of 3% and the width of cages is subject to a tolerance of 3% up to a maximum of 25 mm.

(f) Unit Weight Requirements and Test

The unit weight of the filled gabion basket shall be at least 1600 kg/ cu. m (100 pounds per cubic foot). Should the unit weight be less than 1600 kg/ cu. m, the gabion will be rejected.

The Contractor shall conduct unit weight tests to prove the density of completed gabions by weighing a selected gabion basket filled with stones.

One unit weight test shall be conducted for each 500 cu. m of gabion placed.

9104 CONSTRUCTION OF GABIONS

(a) Preparation of the Foundation and Surface for Bedding

The bed, on which the gabion cages are to be laid prior to filling, has to be leveled to a depth as shown on the drawings or as directed by the Engineer so as to present an even surface.

If necessary, cavities between rock protrusions shall be filled with material similar to that specified in Sub-clause 9102(a).

Where required, a foundation trench along the toe of the revetment or wall shall be excavated to the dimensions shown on the drawings or indicated by the Engineer.

(b) Assembly

The methods of erection, stretching, aligning, wiring and filling the gabions shall generally be in accordance with the manufacturer's instructions as approved by the Engineer but, nevertheless, sufficient connecting wire braces shall be provided and tensioned between the vertical sides of each of the outer visible cells to prevent the deformation of boxes as they are being filled with stone.

It is essential that the corners of gabion cages be securely wired together to provide a uniform surface and ensure that the structure does not appear as a series of posts or panels. Consecutive courses of boxes should preferably be 'bonded' as in brickwork to avoid the coincidence of vertical joints.

(c) Rockfilling

(i) Boxes in Retaining Walls

Particular care shall be exercised in filling visible faces of gabion boxes where only selected stone of adequate size shall be used and prepacked to obtain a fair faced finish.

The filling of boxes shall be done in stages in order to prevent deformation and bulging. Boxes shall be filled to just below the level of the wire braces after which the braces shall be twisted to provide tension.

Care must be taken to ensure that consecutive layers of cages being filled are filled evenly to a level surface ready to receive the next course.

(ii) Mattresses used in Revetments and Aprons

The filling of the 0.3 m and 0.5 m gabions forming aprons and revetments has to be carried out by spreading random stones on the first layer and using selected stones for the top layer so as to present a dry stone-pitched surface.

(d) Gabions using PVC Coated Wire

When gabions using PVC coated wire is specified, the wire used for the gabion mesh, and for wiring the gabions during construction shall be galvanized wire as specified in Clause 9102(b) onto which is extruded a polyvinylchloride (PVC) coating.

The average thickness of the PVC coating shall be as specified, either 0.30 mm for use in mildly corrosive conditions or 0.55 mm for use in marine and other severely corrosive or abrasive conditions.

The minimum thickness of the coatings shall be 0.25 mm and 0.4 mm respectively, and the coatings shall be capable of resisting the deleterious effects of natural weather and salt-water exposure.

The PVC coated gabions shall be of a proven brand and the brand shall be subject to the Engineer's approval.

9105 MEASUREMENT AND PAYMENT

Item 91.01 Foundation trench excavation and backfilling

(a) In solid rock (material requiring blasting) .....cubic meter (m^3)

(b) In all other classes of material .....cubic meter (m^3)

The unit of measurement shall be the cubic meter of each class of excavation made in accordance with the authorized dimensions.

The tendered rates shall include full compensation for excavating in each class of material including for unavoidable over break, for trimming trenches and compacting trench inverts, for backfilling and consolidating backfill, and for disposal of surplus excavated material.

Item 91.02 Surface preparation for bedding of gabions.....square meter (m^2)

The unit of measurement for the leveling and preparation of areas to receive gabions shall be the square meter to the neat dimensions of wall foundations, revetments, or aprons.

The tendered rate shall include full compensation for the excavation, filling cavities with rock; for leveling the ground surface ready to receive gabion cages in retaining walls, aprons, and revetments.

Item 91.03 Gabions

(a) Gabion boxes (Type, size of box and mesh indicated) .....cubic meter (m^3)

(b) Gabion mattresses (Type, depth of mattresses, mesh size an diaphragm spacing indicated).....cubic meter (m^3)

The unit of measurement shall be the cubic meter of the rock-filled cages and the quantity shall be calculated from the dimensions of the gabions indicated on the drawings or prescribed by the Engineer, irrespective of any deformation or bulging of the completed gabions.

The tendered rates shall include full compensation for supplying all the materials, including rock fill, wire-mesh cages, galvanizing, PVC-coating, tying and connecting wires, loading, transporting and off-loading, the assembling and filling of the cages, and any other work necessary for constructing the gabions.

Item 91.04 Filter fabric .....square meter (m^2)

(type and grade indicated)

The unit of measurement shall be the square meter of area covered with filter fabric placed in position.

DIVISION 9200 : DELINEATORS, MARKERS AND KILOMETRE POSTS

9201 SCOPE

This Division covers the supply and erection of delineators, markers and kilometer posts in positions and in accordance with the dimensions as shown on the drawings or as directed by the Engineer.

9202 MATERIALS

(a) Flexible Delineators, Markers, and Kilometers Posts

Flexible units shall be made of a fiberglass reinforced, thermosetting, high polymer resin, an extruded polycarbonite resin, or other materials, which are resistant to ultraviolet and infrared radiation, and which meet the following minimum physical and performance requirements:

(i) Dimensions

1) Ground Mounted

Ground mounted flexible units shall have a minimum width of 75 millimeters and a minimum thickness of 3 millimeters. The length of each unit shall be variable such that the top of the reflective area is positioned 1200 millimeters above the near roadway edge.

2) Guide Rail Mounted

Beam guide rail mounted flexible units shall have a minimum width of 75 millimeters and a minimum thickness of 2.5 millimeters. Each unit shall have a variable height such that the top of the reflective area is 800 ± 50 millimeters (1000 ± 50 millimeters for deceleration and acceleration lanes) above the near roadway edge.

The base of each unit shall be designed to mount over the I-beam spacer, or to the top of a wood, polymer, or other type of spacer, of the beam guide rail.

3) Barrier Curb Mounted

Concrete barrier curb mounted flexible units shall be the same as for beam guide rail mounted units except that the panel shall be 90 by 90 millimeters with a minimum thickness of 2.5 millimeters. The base shall form a “T” shape with the panel.

(ii) Composition

Flexible units shall contain a minimum of 40 percent consumer recycled material in its construction.

For ground mounted flexible units, the portion of the unit above ground shall be one component, or shall be bonded together if it consists of two or more components. The shape of the ground mounted unit shall be conducive to protection of the applied retroreflective sheeting from abrasion.

The base and panel for beam guide rail or concrete barrier curb flexible units shall be designed to withstand repeated impacts, after which, the panel returns to its functioning position (90 degrees from the plane of the roadway surface).

(iii) Color

Flexible units shall be white or opaque in color.

(iv) Impact Resistance

Flexible units shall be self-erecting to within 10 degrees of original upright position within 15 minutes of impact on five separate occasions by a vehicle traveling at 90 kilometers per hour. Tests shall be conducted at zero degrees, 22 degrees, and 45 degrees, variance of the long cross-sectional axis of the unit to the perpendicular of vehicle direction. The same unit(s) shall be used for all angle impact tests, total impacts per unit equaling 15. The re-erected unit shall retain the original cross-section, show no evidence of shedding or splintering, and shall retain 80 percent of its original retroeflective sheeting.

(v) Heat Resistance

A unit shall be conditioned in an oven for two hours at $60 \pm 2^{o}C$. After removal from the oven, the unit shall be bent backwards at 90 degrees from the upright, simulating a field hit. The unit shall, without cracking, recover to its original position within ten seconds for each of three bends. Testing shall be complete within two minutes. Color shall remain unchanged.

(vi) Cold Resistance

The same units(s) tested for heat resistance shall be tested for cold resistance. The unit shall be conditioned for 24 hours at $-18^{o}C$, then subjected to the same testing as for heat resistance. The unit shall conform to the same recovery and color retention standards as for heat resistance.

(vii) Weather Resistance

A unit shall be exposed to 1 000 hours of weathering in accordance with ASTM G 26 with no significant discoloration.

(viii) Installation

Ground mounted flexible units shall be capable of being driven by hand into the ground by only one person to proper depth without damage to the unit. The unit shall remain in the position in which it is installed. All special fittings, attachments, or special tools shall be compatible with that type of flexible unit. The unit's manufacturer shall provide installation instructions and make available all special tools required for installation.

(ix) Depth indicator Mark

A depth indicator mark shall be located on the front (reflective) face of the drivable ground mounted flexible units at a height of 450 millimeters from the bottom end of the unit with a weather resistant marking material so as to not wash off or weather away prior to unit installation.

(x) Mowability

Ground mounted flexible units shall be capable of being mowed over in both directions a total of 20 times (ten each direction) by a standard flail mower equipped with a front-mounted deflector and adjusted to a minimum mowing height of 75 millimeters, without damage. Mowable, drivable, flexible units must fold parallel and flat to the ground so as to not deflect upward and into the flail mower mechanism passing above and over the unit causing any damage thereto.

(xi) Sampling Rate

Five samples per lot size of approximately 10 000 to 20 000 units will be chosen at random by the Engineer for laboratory testing.

(b) Concrete Posts

(i) Concrete

Concrete work shall be carried out in accordance with the provisions of Division 8400.

(ii) Paint

Paint for posts shall be selected from ERA's list of approved road sign paints. Paint for the top of the post shall be selected from ERA's list of approved retro- reflective road sign paints.

9203 MANUFACTURING: CONCRETE POSTS

Posts shall be manufactured to the dimensions shown on the drawings, or as directed by the Engineer. A mixture of four parts concrete sand to one part Portland cement shall be used. Forms shall be smooth and have accurate dimensions. The mixture shall be placed in the forms and vibrated on a vibrating table or by means of other approved methods. The posts shall be reinforced as shown on the drawings and shall have an F3 surface finish.

The posts shall be true to shape, smooth, and without honeycombing or other blemishes.

The recess near the top of the post shall be painted with the reflecting paint specified, while the remainder of the top half of the post shall be painted with white road marking paint.

9204 SPACING OF POSTS

The spacing of units shall be as shown on the drawings or as directed by the Engineer.

9205 ERECTION

(a) Ground Mounted Flexible Units

Flexible units shall be driven vertically into the ground to a minimum depth of 450 millimeters. Units shall be installed so that the plane face of the center of the reflective area is at an angle of zero degrees with a perpendicular to the direction of traffic.

Retroreflective sheeting, Type IV-A shall be pre-applied to the front (surface facing traffic) of the unit by the manufacturer. The retroreflective sheeting shall cover a minimum area of 75 by 300 millimeters, beginning a maximum of 50 millimeters from the top of the post. The color shall be white when the delineator is located on the right side to the direction to traffic and shall be yellow when the delineator is located on the left side to the direction of traffic.

(b) Guide Rail Mounted Flexible Units

Flexible units shall be mounted on the spacer of beam guide rail using either a "U" channel base on the I-beam spacer or a flat base attached to a wood, polymer, or other solid top spacer. The base shall be attached to the spacer using an adhesive recommended by the manufacturer of the base and panel. The first unit shall be placed on the beam guide rail end

treatment, positioned so that the reflector area is facing the direction of traffic, then subsequently every 25 meters (13 sections of guide rail) for tangent mainline roadway, and every 13.5 meters (seven sections of guide rail) for curved mainline roadways with radii less than 580 meters. If a parabolic flare in the beam guide rail exists, the second unit shall be placed at the end of the flared section with subsequent units spaced as stated above. If the distance between the end of the beam guide rail is greater than 6 meters on curved mainline roadways, or 12 meters on tangent mainline roadways, a unit shall be installed on the last post or end treatment.

Retroreflective sheeting, Type IV-A shall be applied to the upper portion of the flexible unit panel. The retroreflective sheeting shall cover a minimum area of 115 by 115 millimeters (115 by 230 millimeters for deceleration and acceleration lanes). The color shall be white when the delineator is located on the right side to the direction of traffic and shall be yellow when the delineator is located on the left side to the direction of traffic.

(c) Barrier Curb Mounted Flexible Units

The first flexible unit shall be placed at the beginning of the concrete barrier curb section, positioned so that the reflector area is facing the direction of traffic, then subsequently every 24 meters. If the distance between the end of the concrete barrier curb and the adjacent unit is greater than 12 meters, a unit shall be installed on both sides of barrier curb openings.

Concrete barrier curb mounted flexible units shall be attached to the side of the barrier curb, 75 millimeters from the top of the barrier, using a method recommended by the manufacturer of the unit.

Retroreflective sheeting, Type IV-A shall be applied to the upper portion of the flexible unit panel facing traffic and perpendicular to the top of the concrete barrier curb. The retroreflective sheeting shall cover an area of 90 by 90 millimeters. The color shall be white when the delineator is located on the right side to the direction to traffic and shall be yellow when the delineator is located on the left side to the direction of traffic.

(d) Concrete Posts

Posts shall be erected after completion of the bituminous surfacing.

Holes shall be excavated in the shoulder and posts placed vertical and square to the road centerline.

Backfilling shall be compacted in layers not exceeding 150 mm thick right from the bottom of the hole. Surplus excavated material shall be disposed of to spoil.

The posts shall be painted immediately after placing.

9206 MEASUREMENT AND PAYMENT

Item 92.01 Delineators, markers and kilometer posts

(a) Delineators (material) ..... number (No.)

(b) Markers (material) ..... number (No.)

(c) Kilometer posts (material). .....number (No.)

The unit of measurement shall be the number of units supplied and erected according to the Specifications.

The tendered rate shall include full compensation for the supply of all materials and labor for making, transporting, setting out, excavation and backfilling of all holes and the disposal of surplus excavated material placing, painting, equipment, tools and incidentals necessary to complete the Works described in this Division.

DIVISION 9300: GUARDRAILS

9301 SCOPE

This Division covers the supply, installation and maintenance of metal plate beam guardrails at locations and in conformity with the details, dimensions and design shown on the drawings or as directed by the Engineer.

9302 MATERIALS

(a) Guardrails

Dimensions of guardrails and terminal sections shall be as shown on the drawings.

Guardrails shall be supplied together with all bolts, nuts, washers and fixing materials required other than bolts for fixing to posts.

The W-beam rail element, backup plates, and terminal sections shall consist of 12 gage steel formed into a beam not less than 12 inches (300 mm) wide and 3 inches (75 mm) deep. The 6 inch channel rail and splice plate shall be in conformance with AASHTO M 183.

Beam rail elements and terminal sections shall be galvanized in accordance with AASHTO M 180, Class A, Type 2. The minimum average weight of Zinc coating shall be 2 ounce per sq. foot. Bolts, nuts, washers, plates, rods and other hardware shall be galvanized in accordance with ASTM A 153.

OR

Guardrails shall comply with the requirements of BS 149. When galvanized guardrails are called for on the drawings or in the Bill of Quantities, a hot-dip galvanized zinc coating that complies with the requirements of BS 763 for coatings on Type A1 articles shall be applied.

All bolts, nuts and washers shall have a hot-dip galvanized zinc coating that complies with the requirements of BS 763 for coatings on Type C1 articles. Galvanized guardrails shall not be nested when stacked for storage.

(b) Guardrail Posts

Normally only concrete posts shall be used for supporting the guardrails, but under certain circumstances, timber or box beam posts may be used. Concrete posts shall be of the type and size shown on the drawings or described in the project specifications.

Box beam posts shall conform to AASHTO-AGC-ARTBA *A Guide to Standardized Highway Barrier Hardware,* 1995 Edition.

Timber posts shall be supplied in lengths as shown on the drawings and comply with the requirements of AASHTO M168 or BS 457.

Posts shall have a top diameter of at least 150 mm. Posts with a top diameter up to 230 mm will be acceptable, provided that posts of widely varying diameter are not used together in the same length of guardrail.

Posts shall be drilled and shaped as shown on the drawings and provided with the necessary bolts, nuts, washers and spacer posts for fixing.

Timber posts and spacer blocks shall be preserved in accordance with any method specified in AWPA C14 or BS 4072. No cutting, drilling or shaping will be permitted subsequent to preserving. Where cutting of posts is, however, unavoidable, the Engineer may permit that the required length be cut off the bottom of a post provided the exposed area is subsequently treated.

Timber posts shall not exhibit excessive cracking at the ends particularly cracks aligned at an angle of more than 45 degrees to the guardrail. Posts, which, in the opinion of the Engineer, exhibit a degree of cracking that, would seriously impair their life or strength shall not be used.

9303 ERECTION

The holes for the posts shall be of sufficient size to permit proper setting of the posts and to allow sufficient room for backfilling and tamping. At least 1 m of the posts shall be embedded in the ground.

The holes for the posts shall be spaced to suit the standard length of guardrail supplied. Where shown on the drawings or directed by the Engineer, posts shall be set at half spacing. The hole for the concrete block at the end of a length of guardrail shall be neatly excavated and the top 120 mm shall be shuttered.

The posts, spacer blocks (if applicable) and guardrails shall be completely erected, set true to line and level, so that the rail is at the required height above the level of the completed road shoulder and the lap shall be in the direction of the traffic movement. The guardrail shall be suitably braced to prevent any movement, and all bolts tightened prior to any backfilling of holes.

After the Engineer has signified his approval of the guardrails so erected, the holes shall be backfilled with a 12:1 soil:cement mixture. The material may be either mixed by hand or mechanically and the correct quantity of water added to ensure that the mixture is placed at or near to optimum moisture content. The mixture shall then be placed and thoroughly rammed in layers not exceeding 100 mm compacted thickness. The approach ends, where the guardrail has to be bent down and anchored, shall be constructed as shown on the drawings.

When the backfilling is complete and the bracing removed, the posts must be rigid, vertical and the guardrail true to line and level and firmly fastened to the posts. Excess excavated material shall be disposed of as directed by the Engineer.

All guardrails shall be erected in such a way that there are no projecting ends that might interfere with or endanger traffic. The edges and the center of the rail element shall contact the spacer block, or the post where no spacer blocks are used. Guardrail elements shall lap in the direction of the traffic and, if specified, guardrails shall be provided with terminal sections, which shall be lapped on the traffic face. All splices of rail elements shall be at a post, and plate ends shall make contact through the entire area of the splice.

Guardrails installed with non-buried, blunt ends shall employ reflective tape on the blunt end. Such preformed reflective tape shall be furnished in 100mm wide rolls conforming to ASTM D 4592, type 1.

9304 REQUIREMENTS

The completed guardrail shall be neat, and there shall be no visible deviations from line and grade. The posts shall be straight and vertical. The rail beam shall not be warped but shall be in a vertical plane parallel to the road centerline except at flared sections. The galvanized

surface on the rail shall be smooth and continuous, free from abrasions and scratches. Any damage to the surface shall be made good at the Contractor's expense.

Guardrails not complying with the specified requirements shall be replaced or otherwise made good.

9305 MEASUREMENT AND PAYMENT

Item 93.01 Guardrails on [material] posts Galvanized .....meter (m)

The unit of measurement shall be the meter of guardrail as erected excluding end units, miter units.

The tendered rate shall include full compensation for furnishing all materials and labor and for erecting the guardrails complete with posts, spacer blocks, bolts, nuts, washers, reinforcing plates and for excavating and backfilling post holes and removing surplus excavated material.

Item 93.02 End units and miter units

(a) End units .....number (No.)

(b) Terminal return unit .....number(No.)

The unit of measurement shall be the number of units of each type erected.

The tendered rates shall include full compensation for all labor, plant and materials required to install the units as shown on the drawings.

DIVISION 9400: ROAD SIGNS

9401 SCOPE

This Division covers the supply and erection of permanent road traffic signs alongside and over the carriageway, ramps and crossroads at interchanges and at the locations indicated on the drawings or as directed by the Engineer. The signs shall be of the standard regulatory, warning and information signs as detailed on the drawings and shall comply with prevailing Regulations except where otherwise indicated on the drawings.

9402 MATERIALS

(a) Structural Steel

Structural steel shall comply with the requirements of AASHTO M270 grade 250 or BS 4360 for the type of steel specified or shown on the drawings. All structural steel, including posts, shall be galvanized in accordance with the requirements of ASTM A123 or BS 729.

Steel posts shall comply with the requirements of ASTM A499 or BS 4848 Part 2.

(b) Aluminum

Sheet Aluminum signs shall be constructed of material conforming to ASTM B 209M alloy 6061-T6 or alloy 5052-H38

Aluminum plate shall 2.0 mm in thickness.

Aluminum posts shall be of the sizes detailed on the drawings and shall conform to the provisions of ASTM B221M or BS 1474 (HE.9).

(c) Bolts, Nuts and Rivets

Bolts, nuts, and washers shall be of the same material for each attachment, and meet the following requirements:.

Bolts..... ASTM B 209 2024-T4 Aluminum
..... ASTM A 307 Steel
..... ASTM F 593 Stainless Steel

Washers..... ASTM B 209 2024-T4 Aluminum
..... AASHTO M 183 Steel
..... ASTM A 240 Stainless Steel

Nuts..... ASTM B 211 2017-T4 Aluminum
..... ASTM A 307 Steel
..... ASTM F 594 Stainless Steel

Locknuts.....ASTM B 211 2017-T4 Aluminum

.....ASTM A 307 Steel

.....ASTM F 594 Stainless Steel

Rivets .....ASTM B 209 6061-T6 Aluminum

Post Clips .....ASTM B 179 356 T-T6 Aluminum

Angle and Z-Bar.....ASTM B 209 6061-T6 Aluminum

Strap & Mounting Bracket.....ASTM A 412, type 201

All steel parts shall be galvanized per ASTM A 123. Steel bolts and related hardware shall be galvanized per ASTM 153.

Blind rivets used for fixing sign faces to square tubing framework shall be manufactured from or coated with a material that will not cause corrosion through electrolytic action. Blind rivets used for joining aluminum extrusions shall be hardened aluminum blind rivets.

(d) Steel Plate

Steel plate shall be 2.00 mm thick and comply with the requirements of ASTM A525 or BS 4360.

Unless otherwise or shown on the drawings, steel plate shall be galvanized in accordance with the requirements of ASTM A525 or BS 729 (Heavy grade).

(e) Particle Board

Particle board shall be an exterior grade timber particle board 12.7 mm thick, unless otherwise specified or indicated on the drawings, and consisting of a phenolated, resin bound timber particle core faced with a phenolated resin impregnated paper overlay, heat bonded under high pressure to form a homogeneous structure.

The particleboard shall comply with the relevant physical requirements for Type B-B NIST specification PS-1 or Type M board as specified in BS 5669.

(f) Concrete

Concrete shall be manufactured and placed as specified in Division 8400. Normally Class 20/20 concrete shall be used for the erection of road signs, unless otherwise shown on the drawings or directed by the Engineer.

(g) Fiberglass

Fiberglass reinforced thermoset polyester laminate panel shall be acrylic modified and UV stabilized for outdoor weather-ability.

Make fiberglass reinforced panels conform to the following mechanical and physical properties:

Mechanical Property	Averaged Minimum Requirement	ASTM Test
Avg. Tensile Strength	69 MPa min.	D638M
Avg. Tensile Modulus	8.3 GPa min.	D638M
Avg. Flexural Strength	140 MPa min.	D790M
Avg. Flexural Modulus	8.3 GPa min.	D790M
Avg. Compression Str.	220 MPa min.	D695M
Avg. Compression Mod.	9.7 GPa min.	D695M
Punch Shear	90 MPa min.	D732
Thickness	3.4 +/-0.1mm	
Size, dimension < 3.7m	+/-3mm	D3841
Squareness in 3.7 m length	+/-3mm	D3841
Surfaces, top and bottom	Smooth	
Color, visually uniform gray, Munsel^{R} range	N.7.5/ - N.8.5/	
Coefficient of lineal thermal expansion	0.01µm/mm/°C max.	D696
Impact resistance, -54 to100°C	0.54 kg from 18.3 m	D3841
Flame resistance	25 mm max.	D635
Weather resistance, 3000 +/-100 h	grade II min.	D3841

(h) Retro-Reflective Material

Retro-reflective material shall be supplied in engineering grade which material shall conform to the requirements of ASTM D 4956 or BS 873 Part 6. It shall be selected from ERA's list of approved retro-reflective materials.

The material shall be supplied with a pressure sensitive or heat applied adhesive backing protected by a removable liner.

(i) Paint

Paints for road signs shall be selected from ERA's list of approved road sign paints. Project acceptance will be based on the appearance of an approved brand name on the container label. All paints and solvents shall conform to Federal air pollution regulations, including those for the control (emission) of volatile organic compounds (VOC) as established by the Environmental Protection Authority.

The paint shall be delivered to the Site in sealed containers bearing the name of the manufacturer and the type of paint.

The viscosity of the paint shall be such that it can be applied without thinning.

(j) Corrosion Protection Tape

Corrosion protection tape used between aluminum and steel shall be "Scotchrap 50" or an equal approved material.

9403 MANUFACTURING OF ROAD SIGN FACES AND SUPPORTS

(a) Road Sign Faces

Road sign faces shall be manufactured in strict accordance with the details of the prevailing Traffic (Signs) Regulations or as shown on the drawings. They shall be manufactured from either steel plate, aluminum plate or fiberglass according to what is specified. Wherever

possible, road sign faces shall be manufactured as one unit. Road signs that are too large to be transported as one unit can, with the approval of the Engineer, be manufactured in sections. The completed sections shall be assembled in the shop prior to delivery to ensure that all sections fit together properly and that the legends are properly spaced and aligned. Joints in sign faces shall only be provided at locations and to details approved by the Engineer. The signs shall be faced with Engineering Grade retroreflective material.

Direct contact between aluminum plate and steel supporting framework shall be avoided by the application of corrosion protection tape to the sign face over the contact areas.

(b) Welding

All welding of steelwork shall be carried out in accordance with the standards laid down in AASHTO/AWS D1.5 Bridge Welding Code or BS 5135. Welding shall be done before painting.

(c) Aluminum Extrusions

Aluminum extrusions for sign faces shall be joined together by blind rivets or bolts. They shall preferably not be joined longitudinally but, if this cannot be prevented without excessive waste, they shall be joined neatly and joints staggered. No sections shorter than 500 mm shall be used.

Where aluminum extrusions are to be faced with retro- reflective background material, it shall be pre-applied to individual sections before assembly with the material taken around the face edges of each extension for at least 10 mm. Retro- reflective material shall be heated to facilitate binding around edges without damaging the material. Where possible, letters across the joint between two extrusions should be avoided.

(d) Galvanizing

Where the galvanizing of structural steel signboard frames and signboard supporting structures is specified, it shall be done as far as is practicable after welding. Where, however, this is not practicable, the steel sections shall be galvanized before assembly and then welded. All welds shall be thoroughly cleaned, loose material removed and dressed after which the welds shall be coated with two coats of an approved zinc-rich paint.

Unless otherwise specified in the Bill of Quantities, galvanized steel posts will not require painting.

Where details for the construction of sign faces, the framework of the sign faces and the attachment thereof to the supporting framework are not shown on the drawings, the Contractor shall design these himself and submit the details to the Engineer for approval before manufacture.

9404 PAINTING

(a) Colors, Symbols and Legend

Paint colors, symbols, legends and borders used on road signs shall comply with the regulations of prevailing Traffic (Signs) Regulations.

The colors and shades shall conform to the colors and shades specified in ERA's approved list of road sign paints.

(b) Preparation of Surfaces and Application of Paint

Immediately before painting, prepare the surface according to the following:

- Clean the surface
- Remove dirt, dust, and other contaminants from the surface using methods recommended by the paint manufacturer
- Thoroughly dry the surface
- Determine that the surface temperature is between 10 and 40°C.
- Determine that the surface temperature is 3°C or more above the dew point according to ASTM E337
- Determine that the humidity is 85 percent or less, unless specified otherwise on the manufacturer's product data sheet

Unless otherwise specified, aluminum and galvanized steel road signs will not require painting.

(c) Time of Painting

Painted shall not be carried out more than six months prior to erection.

(d) Painting of concrete

(i) Surface preparation

The surface of the concrete to be painted shall be cleaned of all dust, loose particles, laitance, scum, and other deleterious materials, washed and allowed to dry.

(ii) Sealing and priming

The surface shall be sealed with an approved clear sealer and primed with undercoat diluted to 50 %.

(iii) Undercoat and finishing

An undercoat shall be applied after priming, followed by two finishing coats of road marking paint. If shown on the drawings, the finishing coats shall consist of a plastic textured coating of a manufacture approved by the Engineer, applied by means of a sponge roller.

9405 STORAGE AND HANDLING

All road signs or portions of road signs shall be so handled and stored in a weather-proof storeroom to prevent any permanent deformation or damage to painted surfaces.

All unpainted surfaces and steelwork shall be protected against corrosion.

9406 ERECTION OF ROAD SIGNS

(a) Position

Road signs shall be erected in the positions shown on the drawings or indicated by the Engineer.

(b) Excavation and Backfilling

Excavations for the erection of road signs shall be made according to the dimensions shown on the drawings. Where the excavations are to be backfilled with soil, a 1:12 cement:soil mixture shall be made and backfilled at optimum moisture content in 100 mm thick layers and compacted to a minimum of 90% of modified AASHTO density.

Where posts or structures are to be fixed in concrete, or where concrete footings are to be cast, the concrete, formwork and reinforcement shall comply with the requirements of Division 8400. The holes shall be completely filled with concrete up to the level shown on the drawings or indicated by the Engineer. The upper surface of the concrete shall be neatly finished with sufficient fall to ensure proper drainage.

(c) Erection

Road signs shall be erected as shown on the drawings or directed by the Engineer. During erection, the structural steelwork shall be firmly bolted and protected in order that no buckling or damage is caused during erection, or by the equipment used for erection. Posts to which road signs are to be fixed shall be vertical, and the undersides of road signs shall be horizontal after completion of erection.

(d) Field Welding

All welding done during erection shall comply with the requirements for welding during manufacture.

(e) On Site Painting

All painting done after erection shall comply with the requirements for painting during manufacture. The Contractor at his own cost shall make all places where the paintwork has been damaged during erection good to the satisfaction of the Engineer.

(f) Time of Erection

Road traffic signs shall be erected immediately prior to the opening of the road to public traffic unless otherwise decided by the Engineer.

9407 PROTECTION AND MAINTENANCE

The Contractor shall protect the completed road signs against all damage until the Employer finally accepts it, and he shall maintain the road signs until the Maintenance Certificate is issued. Damage or defects caused by faulty workmanship or negligence shall be made good by the Contractor at his own cost to the satisfaction of the Engineer.

9408 DISMANTLING, STORING AND RE-ERECTING EXISTING ROAD SIGNS

Where ordered by the engineer, the contractor shall dismantle existing road signs, store them, and re-erect them at new positions indicated. This work shall be done with as little damage as possible to the signs.

Where required by the engineer, the signs shall be repainted or repaired and new materials shall be used for part or all of the supporting structure.

9409 MEASUREMENT AND PAYMENT

Item 94.01 Sign faces with painted background. Symbols, lettering and borders in Engineering grade retro-reflective material with signboard constructed from:

(Specify material and thickness)

(a) Area not exceeding 2 sq m ..... square meter (m^2)

(b) Area exceeding 2 sq m but not 10 sq m ..... square meter (m^2)

The unit of measurement shall be the square meter of completed sign face surface area.

The tendered rate shall include full compensation for the provision of the completed sign board face, frame and fixing brackets, including painting, galvanizing if specified, reflective lettering, symbols, legend and border, and for all other materials and workmanship, brackets, bolts, nuts, etc., for the completion of the signboard faces as specified.

Item 94.02 Sign supports:

(a) Concrete, Class A ..... each (ea)

(b) Steel ..... each (ea)

The unit of measurement for supporting structures shall be each support. Bolts and other accessories shall not be measured.

The tendered rate shall include full compensation for the erection of the road signs and the manufacture and erection of the supporting structures, including all bolts, screws, and accessories, together with painting required.

Item 94.03 Concrete in road sign footings including excavation and backfilling

(class indicated) ..... cubic meter (m^3)

Measurement and payment shall be made as specified in Division 8400.

The unit of measurement shall be the cubic meter of concrete placed measured in place according to the neat dimensions of the footing as shown on the drawings or directed by the Engineer.

The tendered rate shall be in full compensation for concreting, excavating, backfilling and compacting the backfill material, for the disposal of all surplus excavated material.

Item 94.04 Dismantling, storing and re-erecting road signs with a surface area of:

(a) Up to $2m^2$ ..... number (No)

(b) Exceeding $2m^2$ but not $10m^2$ ..... number (No)

The unit of measurement shall be the number of signs dismantled, stored and re-erected in each size group.

The tendered rates shall include full compensation for dismantling and storing the road signs and supporting structures, transporting the material to a new location, re-erecting the road signs, and restoring the location where they were dismantled.

The tendered rates shall also include full compensation for demolishing the concrete footings of existing signs to at least 200 mm below the adjacent ground level, disposing of the resulting debris at approved dumping sites provided by the contractor, and cutting concrete or steel support structures at not less than 200 mm below the adjacent ground level.

Payment for excavations, and the new material and concrete required for re-erecting the road signs shall be made under the appropriate item, and any repairs and painting which may be necessary, shall be paid for as "extra work". No separate payment shall be made for new bolts and nuts required for such re-erection, the cost of which shall be included in the rates tendered above.

Item 94.05 Dismantling and storing road signs with a surface area of:

(a) Up to $2m^2$ .....number (No)

(b) Exceeding $2m^2$ .....number (No)

The unit of measurements shall be the number in each size group dismantled and stored.

The tendered rates shall include full compensation for carefully dismantling and disassembling the road signs, loading, transporting, off-loading and carefully stacking all the materials as required by the engineer. It shall also include compensation for restoring the site where the road signs have been dismantled.

The tendered rates shall also include full compensation for demolishing the concrete footings of existing signs to at least 200 mm below the adjacent ground level, disposing of the resulting debris at approved dumping sites provided by the contractor, and cutting concrete or steel support structures at not less than 200 mm below the adjacent ground level.

Note:

Concrete, formwork and reinforcing steel for road sign footings shall be measured and paid for in accordance with the provisions of sections 8200, 8300 and 8400, but such payment items shall appear under this section in the schedule of quantities.

DIVISION 9500: ROAD TRAFFIC MARKINGS AND ROAD STUDS

9501 SCOPE

This Division covers the permanent marking of the road surface with white or yellow painted lines or symbols as indicated on the drawings or where required by the Engineer. It also covers the supply and fixing of retro-reflective road studs.

9502 MATERIALS

(a) Road-Marking Paint

Paint for applying road traffic markings shall be selected from ERA's approved list of white and yellow road-marking and retro-reflective road marking paints. Project acceptance will be based on the appearance of an approved brand name on the container label. All paints and solvents shall conform to Federal air pollution regulations, including those for the control (emission) of volatile organic compounds (VOC) as established by the Environmental Protection Authority.

The paint shall be delivered to the Site in sealed containers bearing the name of the manufacturer and the type of paint.

The viscosity of the paint shall be such that it can be applied without thinning.

(b) Retro-reflective road-marking paint

Retro-reflective road-marking paint shall comply with the requirements of subclause 9502 (a)

(c) Thermoplastic road-marking material

Where specified in the project specifications, thermoplastic road-marking material shall comply with the requirements of AASHTO M249.

(d) Color

The color to be used shall be bright white or yellow.

Beads

Retro-reflective glass beads shall comply with AASHTO M247 Type T.

9503 WEATHER LIMITATIONS

Road marking paint shall not be applied to damp surfaces or when the relative humidity exceeds 80%, or at temperatures lower than 10`C, or when, in the opinion of the Engineer, wind strength is such that it may adversely affect the painting operations.

9504 MECHANICAL EQUIPMENT FOR PAINTING

Unless otherwise approved by the Engineer the equipment shall consist of apparatus to clean the surfaces, a mechanical road painting machine and all additional hand-operating

equipment necessary to complete the work. The mechanical road marking machine shall be capable of painting at least two lines simultaneously and shall apply the paint to a uniform film thickness at the rates of application specified hereinafter. The machine shall be so designed that it will be capable of painting the traffic markings to a uniform width with sides within the tolerances specified hereinafter, without the paint running or splashing. The machine shall further be capable of painting lines of different widths by adjustment to the spray jets on the machine or by means of additional equipment attached to the machine.

9505 SURFACE PREPARATION

Traffic markings shall be applied to bituminous surfaces after sufficient time has elapsed to ensure that damage will not be caused to the painted surface by volatile substances evaporating from the bituminous surfacing. In no case shall traffic markings be applied until at least two weeks after the completion of the bituminous surfacing or any longer period, required by the Engineer, has expired. Before the paint is applied, the surface shall be clean and dry and completely free from any soil, grease, oil, acid or any other material which will be detrimental to the bond between the paint and the surface. The portions of the surface where the paint is to be applied shall be properly cleaned by means of watering, brooming or compressed air if required.

9506 SETTING OUT OF ROAD TRAFFIC MARKINGS

The lines, symbols, figures or marks shall be set out by means of paint spots of the same color as the proposed final lines and marks. These spot marks shall be at such intervals as will ensure that the traffic markings can be accurately applied, and in no case shall they be more than 1.5 m from each other. Normally spots of approximately 10 mm in diameter should be sufficient.

The dimensions and positions of traffic markings shall be as shown on the drawings or as specified in the prevailing Traffic Regulations.

After spotting, the positions of the proposed road markings such as dotted lines and starting and finishing points of barrier lines are to be indicated on the road. The Engineer prior to the commencement of any painting operations must approve their premarkings.

The positions and outlines of special markings are to be produced on the finished road in chalk and are to be approved by the Engineer before they are painted. The use of approved templates will be permissible on the condition that the Engineer approves the positioning of the marking before painting is commenced.

9507 APPLICATION OF PAINT

Paint shall be applied as figures, signs, letters, symbols, broken or unbroken lines or other marks as shown on the drawings or directed by the Engineer.

Where the paint is applied by means of a machine, it shall be applied in one layer. Before the road marking machine is used on the permanent works, the satisfactory working of the machine shall be demonstrated on a suitable site, which is not part of the permanent works. Further testing shall follow adjustment to the machine. Only when the machine has been correctly adjusted, and the use thereof approved by the Engineer after testing, may the machine be used on the permanent work. The operator shall be experienced in the use of the machine.

After the machine itself has been satisfactorily adjusted, the rate of application shall be checked and adjusted if necessary before application on a large scale is commenced.

Where two or three lines are required next to each other, the lines shall be applied simultaneously by the same machine. The paint shall be stirred before application in accordance with the manufacturer's instructions. Paint shall be applied without the addition of thinners. Where painting is done by hand, it shall be applied in two layers, and the second layer shall not be applied before the first layer has dried out sufficiently. As most road marking paint reacts with the bitumen surface of the road, the paint is to be applied with only one stroke of the brush or roller at any one point on the road.

Ordinary road marking paint shall be applied at a nominal rate of 0.42 liter/sq. m, or as directed by the Engineer.

9508 APPLICATION OF RETRO-REFLECTIVE BEADS

Where retro-reflective paint is required, the retro-reflective glass beads shall be applied by means of a suitable machine immediately after the application of the paint in one continuous operation. The rate of application of the beads shall be 0.8 kg/liter paint or such other rate as may be indicated by the Engineer. Machines, which apply the beads by means of gravity only, shall not be used. The beads shall be sprayed onto the paint layer.

Upon approval by the Engineer, paint rollers or brushes may be used for marking letters, symbols, stop bars, short temporary detours or other such areas as directed by the Engineer. When rollers and brushes are allowed, glass beads shall be applied to the wet paint film at the specified rate and in a manner suitable to the Engineer.

9509 ROAD STUDS

Road studs shall be of the types indicated on the drawings and shall be fixed in the positions indicated and approved by the Engineer.

Before fixing, the surface shall be thoroughly cleaned as specified in Clause 9505.

The studs shall be fixed to the road surface by means of an approved epoxy resin in accordance with the manufacturer's instructions after the road lines have been completed. Sufficient adhesive shall be used to give complete coverage of the contact area and to provide a slight excess. The road studs shall be pressed on the prepared area and all excess adhesives pressed out. The excess adhesive shall then immediately be removed with a suitable solvent. The studs shall be protected against impact until the adhesive has hardened.

9510 TOLERANCE REQUIREMENTS

Road traffic markings shall be constructed to an accuracy within the tolerances given below:

(a) Width

The width of the lines and other markings shall not deviate from the specified width by more than 5%.

(b) Position

The position of letters, figures, arrows, and other markings shall not deviate from the true position specified by more than 20 mm.

(c) Alignment of Markings

The alignment of any edge or a longitudinal line shall not deviate from the true alignment by more than 10 mm in 15 m.

(d) Broken Lines

The length of segments of broken longitudinal lines shall not deviate from the specified length by more than 150 mm.

9511 GENERAL

The broken lines, the length of segments and the gap between segments shall be as indicated on the drawings. If these lengths are altered by the Engineer, the ratio of the lengths of the painted section to the length of the gap between painted sections shall remain the same. Lines shall not be painted more than 3 months prior to opening of the road to public traffic.

Lines on curves, whether broken or unbroken, shall not consist of chords but shall follow the correct radius.

9512 FAULTY WORKMANSHIP OR MATERIALS

If any material not complying with the requirements is delivered on the Site or used in the Works, or if any sub-standard work is carried out, such material or work shall be removed, replaced or repaired as required by the Engineer at the Contractor's own cost. Rejected traffic markings and paint which has been splashed or dripped on the surfacing, kerbs, structures or other such surfaces, shall be removed by the Contractor at his own cost, in such a way that the markings or spilt paint will not show up again later.

9513 PROTECTION

After the application of paint, the traffic markings shall be protected against damage by traffic or other causes. The Contractor is responsible for the erection, placing, and removal of all warning boards, flags, cones, barricades, and other protective measures, which may be necessary.

9514 MEASUREMENT AND PAYMENT

Item 95.01 Paint (specify road marking, retro-reflective road marking and/or Thermoplastic)

(a) White lines (broken or unbroken) (width of line indicated) ..... kilometre (km)

(b) Yellow lines (broken or unbroken) (width of line indicated)..... kilometre (km)

(c) White lettering and symbols ..... square meter (m^2)

The unit of measurement for painting of lines is a kilometer of each specified width of line and the quantity paid for shall be the actual length of line painted in accordance with the instructions of the Engineer, including the length of gaps in broken lines.

The unit of measurements for lettering, symbols or traffic island markings is a square meter and the quantity to be paid for is the actual surface area per square meter measured to the nearest $0.01m^2$ of lettering, symbols or traffic markings painted in accordance with the drawings or as directed by the Engineer.

The tendered rate per kilometer or per square meter, as the case may be, for the painting of traffic markings shall include full compensation for the procuring and furnishing of all material and equipment necessary, including the retro-reflective beads in the case of retro-reflective paint, and for painting, protection and maintenance as specified, including the setting out of lettering, symbols and traffic island markings and lines, and control of traffic.

When more than five (5) percent but less than ten (10) percent of the striping varies in position more than specified in ç510 (c) and (d) above, a pay factor of 0.85 will be applied. Striping tolerance that fails the above and is allowed to remain in place will be accepted at a reduced contract unit price based on a pay factor of 0.75.

When paint and reflective beads are not applied at the minimum rates specified, the unit price will be reduced by the sum of the percentages the paint and beads are deficient. Paint and beads will not be accepted if they are applied at less than 70% of the contract requirements.

Item 95.02 Variation in rate of application:

(a) White paint .....liter (l)

(b) Yellow paint.....liter (l)

(c) Glass beads ..... kilogram (kg)

The unit of measurement for variation in rate of application of paint and glass beads shall be a liter and kilogram respectively.

Payments for variations shall be made as specified in the Conditions of Contract.

Item 95.03 Roadstuds (type stated).....number (No)

The unit of measurement for roadstuds shall be the actual number of approved roadstuds placed.

The tendered rate shall include full compensation for procuring and furnishing all the necessary material, labour and equipment, and for fixing and maintenance as specified. Distinction shall be made between various types of roadstuds.

DIVISION 9600: LANDSCAPING AND GRASSING

9601 SCOPE

This Division covers the establishment of vegetation on cut and fill slopes and in areas where the natural vegetation has been cleared or covered.

9602 MATERIALS

(a) Fertilizer

The type of fertilizer to be used shall be one or more of the following as may be specified by the Engineer:

(i) Urea

(ii) Super phosphate

(iii) Muriate of potash

(b) Grass Cuttings

Grass cuttings shall be fresh cuttings of an approved type of grass with sufficient root material where required to ensure good growth.

(c) Grass Seed

Only good quality fresh seed shall be used and the types of seed shall be as specified in the project specification.

(d) Topsoil

Topsoil shall consist of fertile loamy soil, selected from areas showing a good coverage of natural vegetation preferably grasses. It shall be free from deleterious matter such as large roots, stones, and refuse, stiff or heavy clays and noxious seeds, which would adversely affect its suitability for planting grass.

Topsoil shall be obtained wherever suitable material occurs, either in the road reserve from areas where cuts and fills are to be constructed or from borrow areas to be cleared, as described in Clause 4202. The Engineer shall indicate to the Contractor his requirements regarding the quantity of topsoil required and the areas from which it shall be selected and removed. Unless otherwise specified, topsoil shall be taken from not more than 400 mm from the surface. If the Contractor fails to conserve topsoil as instructed, he shall obtain suitable substitute material from other sources at no extra cost to the Employer.

Where so specified, the Contractor shall procure and furnish topsoil from his own sources outside the Site, such sources to be approved by the Engineer.

Topsoil shall be stockpiled in separate loose heaps as tipped from the trucks and shall not be stockpiled higher than 3 m. Care shall be exercised to prevent the compaction in any way of topsoil, especially by trucks travelling over such material.

9603 LANDSCAPING THE AREAS

(a) Shaping

Areas within the road reserve but outside the road prism which require shaping by means of bulk earthworks such as contoured areas at intersections and rest areas which require earthworks shall be excavated, filled and compacted when required, and shaped to the correct contours to within a tolerance of plus or minus 150 mm. Such work shall be regarded as being earthworks and measurement and payment therefor shall be made under Section 4000 except that quantities may be measured by means of a grid system of levels taken at 10m intervals before and after shaping or else it may be determined by leveled cross-sections.

(b) Trimming

Trimming shall consist of trimming the existing or previously shaped ground to an even surface with the final levels generally following the original surface. It is a requirement that the drainage remains effective. Trimming shall be done where instructed by the engineer to areas inside the road reserve but outside the road prism, ie normally outside the tops of cuts or the toes of fills, but trimming of rock outcrops will not be required.

Trimmed surfaces shall be left slightly rough to facilitate a better binding with topsoil or the natural establishing of vegetation.

When subsequent grassing is required or when it is ordered by the engineer, areas previously shaped shall be trimmed as described above to within a tolerance of plus or minus 100 mm with all undulations following a smooth curve. The above tolerance shall apply only to areas where the final contours are given on the drawings.

During trimming, all stones in excess of 50 mm in size and all excess material shall be removed.

9604 PREPARATION OF AREAS FOR GRASSING

The areas to be grassed shall be cleared of all loose stone larger than 100 mm. Where directed by the Engineer topsoil shall be placed and shall be reduced to a fine tilth free of loose stones larger than 100 mm.

Fertilizer shall be distributed at a rate not less than 75 gm/sq. m, prior to grassing.

9605 GRASSING

Provision is made for the following methods:

(a) Planting of Grass Cuttings

The areas to be planted shall, unless wet, be thoroughly watered before planting to ensure that soil will be uniformly wet over a depth of at least 150 mm when planting takes place.

Rooted grass cuttings or reed cuttings shall be evenly planted by hand at a spacing between each cutting of not more than 250 mm in either direction measured on the face of the slope to be grassed. Only fresh cuttings shall be used and no grass cuttings that have been allowed to dry out shall be used. Immediately after planting, the grass cuttings shall be given a copious watering.

(b) Seeding

Seeding can only be carried out after seed has been harvested between the months of June and August and allowed to lie dormant for a period of at least six months. The Contractor shall make his own arrangements for the collection of seed. The seed shall be spread on prepared ground as defined in Subclause 9604 (a) in sufficient quantity to establish an acceptable grass cover as defined in Subclause 9606 (b).

(c) Topsoiling only

Where, in the opinion of the engineer, the planting of grass or seeding can be dispensed with on account of favourable climatic and other conditions, the contractor may attempt to establish grass by topsoiling only. Topsoil shall be selected for the presence of natural grass and seeds and shall be removed and placed whenever possible at a time that would favor the establishing of grass. These areas shall be treated with an anti-erosion compound, if so instructed by the engineer. Fertilizing shall be done as specified in clause 9604;

After the topsoil has been placed, it shall be lightly rolled and well watered, and afterwards watered and mown whenever instructed by the engineer.

The contractor will not be held responsible for establishing an acceptable grass cover as defined in subclause 9606(b) when this procedure is followed, but will be responsible for the consequences of any omission to water or mow or weed the grass as instructed by the engineer.

No payment for grassing shall be made other than for placing topsoil, providing and applying fertilizers and for watering, mowing and weeding the grass, which will be paid for at the tendered rates. For any replanting of grass on bare patches, repairs caused by erosion, and similar work, the contractor will be paid for as a variation in terms of clause 40 of the general conditions of contract.

(d) The grassing of borrow pits, temporary deviations, camp sites, access roads and stockpile sites

Prior to any grassing that may be required on such areas, the finishing-off of borrow pits as described under clause 4304, obliterating the temporary deviations and access roads, and the clearing of camp sites as described in the Conditions of Contract, shall have been carried out as specified in the relevant sections.

9606 ESTABLISHMENT AND MAINTENANCE OF THE GRASS

(a) Watering, Weeding, Cutting and Replanting

All planted areas shall be adequately watered at frequent and regular intervals in order to ensure proper germination of seeds and growth of grass until the grass has established an acceptable cover and, thereafter, until the beginning of the Maintenance Period of the grass. The amount and frequency of watering shall be subject to the Engineer's approval. Watering shall commence and continue as soon as the seeds have germinated and growth begins.

Weeds shall be controlled by means of pulling, cutting or any other approved means. Any bare patches where the grass has not taken or where it has been damaged or dried up, shall be recultivated and planted at the Contractor's own expense.

All grassed areas shall have acceptable cover as defined below at both the beginning and the end of the Maintenance Period indicated in Subclause 9606 (c).

(b) Acceptable Cover

An acceptable grass cover shall mean that not less than 75% of the area planted or seeded shall be covered with grass and that there shall be no bare patches of more than 500 mm in maximum dimension.

(c) Maintenance Period

The Maintenance Period of grass shall commence when an acceptable cover, as defined in (b) above, has been established and shall be one year. This means that the Maintenance Period for grass can commence earlier or later than the Maintenance Period for other portions of the Contract.

If the Maintenance Period for grass expires before the end of the Maintenance Period for the other roadworks, the Contractor shall further mow the grass on such areas as instructed by the Engineer up to the end of the Period of Maintenance for the main roadworks.

9607 GENERAL

(a) Time of Planting

The planting of grass shall be carried out as far as practicable during periods most likely to produce beneficial results. The Contractor shall make every effort to program his operations in such a manner that this is done as far as possible.

(b) Traffic on Grassed Areas

The Contractor shall not plant grass until all operations, that may require road building equipment to be taken over grassed areas, have been completed. No road building equipment, trucks or water carts shall be allowed on areas that have been grassed and only equipment required for the preparation of areas, application of fertilizer and spreading of topsoil will be allowed to operate on areas to be grassed.

(c) Erosion Control

During construction, the Contractor shall protect all areas susceptible to erosion by installing all necessary temporary and permanent drainage works as soon as possible, and by taking such other measures as may be necessary to prevent the concentration of surface water and scouring of slopes, banks and other areas.

Any runnels or erosion channels developing during the Period of Construction or during the Period of Maintenance shall be backfilled and consolidated and the areas restored to their proper condition. The Contractor shall not allow erosion to develop on a large scale before effecting repairs and all erosion damage shall be repaired as soon as possible and, in any case, not later than three months before the termination of the Period of Maintenance. All topsoil or other material accumulated in side drains shall be removed at the same time. Topsoil washed away shall be replaced.

(d) Responsibility for Establishing an Acceptable Cover

The Contractor shall be solely responsible for establishing an acceptable grass cover and for the cost of replanting where acceptable cover is not obtained.

Where, however, in the opinion of the Contractor, it is doubtful from the outset if it will be possible to establish an acceptable cover, he may inform the Engineer of his reasons,

therefore, and the Engineer shall, if he agrees, either allow the Contractor to adopt another method of grassing or agree to accept whatever cover can be obtained, provided that all reasonable efforts are made to establish a good cover using the method proposed.

9608 MEASUREMENT AND PAYMENT

The engineer shall be entitled to pay for shaping and trimming as described above on the basis of hourly plant rates. Any labor or other plant required shall be paid for as a variation as specified in clause 40 of the general conditions of contract.

Item 96.01 Stockpiling of Topsoil..... cubic meter (cu m)

The unit of measurement for stockpiling of topsoil shall be the cubic meter of topsoil stockpiled on instructions from the Engineer.

The tendered rate shall include full compensation for the excavation, loading, transporting, and stockpiling in a condition suitable for later use.

Item 96.02 Preparation of areas for grassing:

(a) Topsoiling ..... cubic meter (cu m)

The unit of measurement shall be the cubic meter of topsoil applied at the specified thickness or as directed by the Engineer, measured in situ after the topsoil has been placed. The quantity shall be calculated from the net area of the surface topsoil multiplied by the average thickness of the topsoil. Any topsoil placed in excess of the average thickness specified or ordered will not be measured.

The tendered rate shall include full compensation for excavating from stockpile or original ground, transport, offloading, placing and spreading it to the required thickness, leveling it off to a smooth surface, for removing any stones as specified, and for roughening the surface to be top soiled.

(b) Provide and apply chemical fertilizers (type).....ton (t)

The unit of measurement of fertilizer shall be the ton of each type of fertilizer ordered and applied.

The tendered rate shall include full compensation for furnishing the fertilizer, transporting it to the point of use, spreading and mixing it into the soil or topsoil.

Item 96.03 Grassing:

(a) Planting of grass cuttings..... hectare (ha)

The unit of measurement for planting of grass cuttings shall be the hectare.

The tendered rate shall include full compensation for furnishing and planting the cuttings, for watering, weeding, replanting if necessary, and all other incidentals that may be required to establish an acceptable cover and maintain the grass, except mowing.

The tendered rates shall include full compensation for all labor, materials, plant, and other incidentals. Topsoiling will be paid for separately under Item 96.02.

(b) Seeding..... hectare (ha)

The unit of measurement for seeding shall be the hectare.

The tendered rate shall include full compensation for procuring and furnishing the seeds, applying the seed, watering, weeding, reseeding bare patches, and for any other work, which may be necessary to establish acceptable cover and maintain the grass.

Half of the payments under this Item shall become due when the grassing or seeding has been carried out, and the remainder will become due when satisfactory cover has been established.

DIVISION 9700: PAINTING OF STEEL

9701 SCOPE

This Division covers the preparation of steelwork to receive protective coatings and the application of those coatings. This applies not only to new steelwork but also to the repair of damaged coatings and those, which are breaking down.

9702 GENERAL.

(a) Specifications

Raw materials for the paints shall conform to the requirements of the specifications listed below:

Alkyd resin solution, Federal TT -R-266, Type 1 or Type II.

Aluminum paste, ASTM D 962, Type 2, Class B

Anti-skinning agent shall be tested in accordance with Federal TestStd.No.141a.Method3021

Barium sulphate pigment. ASTM D 602

Basic lead silico-chromate, ASTM D1648

Chrome Oxide green. ASTM D 263

Chrome yellow pigment and paste, ASTM 0 211, Type III

Liquid drier, ASTM D 600

Mineral spirits, ASTM D 235

Raw Linseed oil, ASTM D 234

Red iron oxide, ASTM D3721, D3722 & D3724

Red lead pigment and paste, ASTM D 83, 97 percent grade.

Turpentine, ASTM D13

Zinc oxide and paste, ASTM D 79

(b) Paint formula

All paints shall be made from materials meeting the requirements specified in (d) above.

The formulas are stated in terms of dry pigment.

(i) Formula A-3-71 -Red Lead Sealing Paste

Red Lead (dry pigment)	88.5 %
Raw Linseed ail	8.5 %
Nonleafing Aluminum Paste	9 %
Weight per US gallon	36.0 pounds
Drying Time	24 hours

(ii) Formula A-4-90 -Phenolic Red Lead Primer

The primer shall meet the requirements of Federal Specification TT -P-86, Type IV

(iii) Formula A-5-61 -Vinyl Pretreatment

The primer shall meet the requirements of Federal Specification MIL-P-15328B or MIL-P-15328C, Primer Pretreatment Formula 117B for Metals. The wash primer coat shall be spray applied at a coverage rate of 250 to 300 square feet per US gallon to yield a dry film of 0.5 to 0.9 mils thickness.

(iv) Formula A-6-86 Zinc Oust Zinc Oxide Primer

The primer shall meet the requirements of Federal Specification TT-P-641

(v) Formula A-9-73 Galvanizing Repair Paint. High Zinc Dust Content

The primer shall meet the requirements of Federal Specification MIL-P-21035

(vi) Formula A-1 0-83 Vinyl Read Lead Primer

The primer shall meet the requirements of Federal Specification MIL-P-23281

(vii) Formula B-4-90 Phenolic First Field Coat for Steel

The phenolic first field coat shall meet the requirements of Federal Specification TT -P-86, Type IV

(viii) Formula B-7-70 First Field Coal for Steel (Basic Lead Sillico Chromate)

The paint shall meet the requirements of Federal Specification TT -P-615, Type Il. Other than color, the characteristics of the B- 7-70 shall be the same as listed for A-7-70.

9703 SURFACE PREPARATION-GENERAL REQUIREMENTS

(a) Before blast cleaning or abrading steel surfaces or before overcoating painted surfaces, contamination by oil or grease shall be removed by wet cleaning the affected areas as described in Clause 9704.

(b) Clean water, which does not leave harmful residues on the surface, shall be used for cleaning and rinsing.

(c) Cleaning agents approved by the Engineer shall be used.

(d) Surface preparation shall be continued until the standard described in the Contract has been achieved.

(e) Weld spatter shall be removed from accessible areas, which are to be painted. Firmly adhering weld spatter in the heat affected zone shall be removed before blast cleaning.

(f) After dry surface preparation of surfaces and before any wet cleaning ail dust and debris shall be removed tram accessible areas by sweeping and vacuum cleaning.

(g) Immediately before application of each coat of paint, the contractor shall ensure that the surfaces:

(i) meet the standard of preparation described in the Contract.

(ii) are free from harmful residues, including dust, grit and paint degradation products.

(iii) are free from detrimental contamination.

(iv) are free from moisture detrimental to the coating to be applied.

(h) Coats of paint shall be free from embedded metallic or other foreign particles including metallic dust. Deposits of adherent matter shall be cleaned off immediately they occur. Coatings damaged in the process shall be restored.

9704 SURFACE PREPARATION-MATERIALS AND METHODS

Abrading on site

(a) Any encrusted foreign matter or paint, which may be difficult to remove by abrading alone, shall with the Engineer's approval be dislodged by scraping, aided by hand or power wire-brushing. The work shall be completed before abrading the areas so affected.

(b) Abrading shall be carried out using abrasive paper or other material or a flexible abrasive disc mounted on a power- driven flexible pad. Abrading tools may be used to remove weld spatter. Wet abrading may be employed for the preparation of finishes over sound undercoats.

(c) A burnished appearance caused by polishing in of paint, rust or dirt will not be acceptable.

(d) Areas of previously corroded steel which have been prepared by abrading down to bright steel and blast cleaned where appropriate, shall be protected by the primer before any cleaning down or preparation of adjacent surfaces.

(e) Wet Cleaning on Site

Wet cleaning shall be carried out by scrubbing with a stiff-bristled brush using water and a cleaning agent. Immediately after cleaning, the surfaces shall be thoroughly rinsed.

(f) Dry Cleaning on Site

Surfaces shall be cleaned by scrubbing with a dry stiff-bristled brush.

(g) Dry Blast Cleaning on Site

The Contractor shall ensure that the grade of non metallic abrasives is adequate for the purpose intended. Non-metallic abrasives shall not be recycled.

9705 PROCEDURES FOR TREATMENT AT AREAS OF MECHANICAL DAMAGE OR OTHER SURFACE DEFECTS

(a) Score marks and indentations in the surface of a steel substrate shall be treated by abrading or grinding to bright steel to produce a surface without sharp edges or abrupt change in contour. Damage to unprepared surfaces shall be treated before blast cleaning. Other surface defects in the steel substrate, including fissures caused by the removal of 'hackles' or inclusions shall be similarly treated subject to the approval of the Engineer.

(b) In the case of damage to paint coatings only, surface preparation shall be by abrading or other method agreed with the Engineer. The paint coatings shall then be restored.

(c) In all cases where paint coats only are to be restored, the edges of paint coatings adjacent to the affected area shall be beveled back into sound paint. This work shall be carried out before any final blast cleaning.

(d) On site, unless otherwise agreed by the Engineer, overcoating shall be started immediately after surface preparation of the affected area and continued as soon as each coat is dry enough for overcoating.

9706 PROCEDURES FOR TREATMENT OF LOCAL FAILURE IN PROTECTIVE COATINGS

(a) On site failed paint coatings shall be restored except that abrading down to sound paint or bright steel and blast cleaning to clean steel, 2nd quality are permissible methods of surface preparation when restoring paint systems over a steel substrate.

(b) In all cases of local failure, the extent of the failure shall be agreed with the Engineer. Restoration of protective coatings shall not be started until the standard of surface preparation, including the cleanliness of the surface has been passed as satisfactory by the Engineer.

9707 WORKMANSHIP STANDARDS FOR THE SURFACE PREPARATION OF STEEL BY BLAST CLEANING, ABRADING, GRINDING AND CLEANING

(a) Blast cleaned surfaces shall be virtually free from sharp spikes of parent metal defined as 'rogue peaks' formed by the impact of abrasive particles and which project above the blast cleaning profile. Any 'rogue peaks' which in the opinion of the Engineer would be detrimental to the protective system shall be removed.

(b) 'Hackles' and inclusions caused by the rolling process, visible after blast cleaning, which in the opinion of the Engineer would be detrimental to the protective system, shall be removed. Affected surfaces shall be prepared by grinding or abrading to bright steel in accordance with clause 9704. Sharp edges shall be rounded.

(c) Steel surfaces to be prepared by any of the methods described in the Contract shall be such that after surface preparation the surfaces shall be free from detrimental contamination.

(d) Surface preparation by blast cleaning shall be to one or more of the following standards of visual cleanliness:

(i) 'Clean steel' 1st Quality

Appearance:

There shall be a blast cleaning pattern overall. The surface profile shall be free from mill scale, rust and foreign matter when viewed through a X10 illuminated magnifying glass of a type approved by the Engineer.

(ii) 'Clean steel' 2nd Quality

Appearance:

There shall be a blast cleaning pattern overall. The surface profile shall be free from mill scale, rust and foreign matter when viewed by normal vision.

(iii) 'Bare steel' (blast cleaned or abraded)

Appearance

The surface shall be tree trom ail rust scale, loose rugI and 100SE mill scale.

(e) After surface preparation by blast cleaning to 1st or 2nd quality the surface profile shall be virtually free from embedded abrasive particles when viewed through a X10 magnifying glass of a type approved by the Engineer. Surfaces assessed as unsatisfactory shall be blast cleaned again with fresh abrasive.

(f) 'Harmful Residues' or 'detrimental contamination':

Surfaces shall be deemed to be free from harmful residues' or 'detrimental contamination' after surface preparation when in the opinion of the Engineer, any remaining matter will not reduce the required durability of the specified protective system.

(g) 'Bright steel':

Surfaces free from defects or prepared to this standard by grinding or abrading shall have an overall bright appearance.

9708 PAINT AND SIMILAR PROTECTIVE COATINGS

(a) All paints shall be supplied in sealed containers of no more than 5 litters capacity and these shall be used in the order of delivery. Each container shall be clearly marked on the side to show the name of the manufacturer, registered description of the material (including purpose, e.g. whether primer, undercoat or finish), color, batch number and date of manufacture.

(b) The contractor shall ensure that the properties of the paints he has selected are suitable for the conditions on site including temperature and humidity, and that he is able to apply the paints satisfactorily to all parts of the structure in these conditions.

(c) Unless otherwise described in the Contract, all paints forming any one protective system shall be obtained from the same manufacturer.

9709 STORAGE REQUIREMENTS AND KEEPING PERIODS FOR PAINTS

(a) On delivery to the site, paint shall be unloaded directly into a secure paint store. Ventilation shall be provided as necessary to maintain the temperature of the paint store between 5 and 27 degrees centigrade. If at any time or place paint in tins or painters kettles is allowed to reach temperatures outside these limits, the paint shall be discarded and not used in the Works.

(b) Paint which has not been used within 12 months of the date of manufacture or the shelf life recommended by the manufacturer shall be discarded and not used in the Works.

9710 APPLICATION OF PAINT

(a) Paint shall be supplied from the Contractor's paint store to the painters ready for application, the only adjustment of formulation being as permitted by the Engineer. Any addition of solvent shall be made in the store in the presence of the Engineer, and shall not exceed 5% by volume of the paint.

(b) Paint shall be applied only to surfaces, which have been prepared and cleaned as described in this series.

(c) A coat of paint in a system shall be applied by brush or approved spray system.

(d) Paint shall not be applied under the following conditions:

(i) when the relative humidity rises above 90%.

(ii) during rain, mist or in a dust laden atmosphere.

(iii) when the amount of moisture likely to be deposited on the surface by condensation or rain before or after painting may have a harmful effect on the paint.

(iv) when wind borne dust may have a harmful effect on the paint.

(e) The Contractor shall furnish the Engineer with details of the overall wet film thickness for each coat he proposes to apply. He shall also provide information as to the total amount of paint he expects to use for each coat of paint. The calculation of the amount of paint to be used shall be based on the volume solids plus an allowance for waste.

(f) The following requirements on paint film thickness shall apply:

(i) Wet film thickness gauges shall be used where practicable to check that the wet film thickness is not less than:

$$\frac{\text{min dry film thickness(mdft)} \times 100}{\text{volume solids \%}}$$

(ii) During the application of a paint system the Contractor shall ensure that the progressive total thickness of the applied coats will allow the specified minimum total dft of the system to be attained without exceeding overall, the proposed wet film thickness referred to in sub-clause (e) of this clause by more than 20%.

(iii) The local dry film thickness for any primer shall not exceed the specified mdft by more than 30% and for other paints by more than 75%.

(g) Each coat of paint of a specified system at whatever thickness applied shall be virtually free from surface defects, particularly crating, pin-holing, blistering, rivaling, sagging, bittiness, dry spray and cissing. The finished system shall have an even and uniform appearance.

(g) All successive coats in a system including the stripe coats shall be in contrasting colors to aid identification.

(h) Stripe Coats.

Unless otherwise described in the Contract two stripe coats shall be applied to all welds and to all external corners. The first stripe coat shall be applied over the primer or sealer, the second stripe coat, in second or third undercoat paint, shall be applied before the last undercoat of the complete system.

(i) Exposure Times for Prepared Steel Surfaces and overcoating Times for Paints.

Clean steel prepared by blast cleaning or bright steel prepared by abrading or by grinding shall be primed within 4 hours.

(j) Prepared steel surfaces which have been restored shall be overcoated with the primer or first undercoat as appropriate before the surfaces have been affected by moisture and in any case within 4 hours.

(k) Steel surfaces, which have been primed or sealed on site shall have the following coat applied within 7 days, the next coat shall be applied within a further 14 days, or such lesser time recommended by the paint manufacturer.

9711 PROCEDURE TRIALS

(a) Unless otherwise described in the Contract, the Contractor shall carry out site procedure trials with the labor and equipment to be used for the work. The trial area shall be at least 1 square meter. The contractor shall demonstrate his ability to carry out blast cleaning and to apply the paints he has selected.

(b) Painting of the main steelwork shall not be started until procedure trials have been completed to the satisfaction of the Engineer.

(c) Any adjustment to the paint formulation shown to be required by the trials, other than an adjustment to the solvent, shall be agreed with the Engineer.

9712 MEASUREMENT AND PAYMENT

Item 97.01 Preparation of steelwork prior to coating

(a) Preparation of bare metal surfaces ..... (m^2)

(b) Preparation of existing metal surfaces ..... (m^2)

The measurement shall be the net surface area to be treated. The items for preparation shall include for the provision and preparation of specimen panels demonstrating the preparation of steelwork, and cleaning and preparing surfaces to be painted including the provision of materials, plant, and power and hand tools.

Item 97.02 Protective system to steelwork

(a) Protective system to bare metal surfaces ..... (m^2)

(b) Protective system to existing steelwork ..... (m^2)

The measurement shall be the net surface area to be treated.

The tendered rate shall include for making good any damage or defect in the surface to be treated and in the finished surface. complying with any special requirements in respect of ambient conditions for the application of protective treatment and for intervals between successive operations and applications, preparing materials for application in accordance with the manufacturer's recommendations, painting of steelwork under cover and everything necessary to facilitate the painting of steelwork on Site, and obtaining the correct dry film thickness of paint and providing an Elcometer to prove this to the Engineer's satisfaction.

DIVISION 9800: FENCING

9801 SCOPE

This work consists of constructing fences and gates. It also covers the moving of existing fences where necessary and the erection of new fences along the boundaries of the road reserve where so indicated on the drawings or directed by the Engineer.

It shall also include the erection and later removal of temporary fences to prevent animals straying onto temporary bypasses or onto the road itself. Except when the Engineer allows otherwise, new fences as well as temporary fences shall be erected before construction of a particular portion of the road commences or before temporary bypasses are open to traffic.

This Division also covers the dismantling of existing fences and the stacking of the fencing material.

9802 MATERIALS

(a) Posts, strays, standards and droppers

Posts, strays and standards shall be of the type and size indicated on the drawings. Wooden posts shall comply with the requirements of AASHTO M168 or BS 1722. Timber posts shall be treated at the Engineer's option with either creosote or copper chrome arsenate, the latter preservative not to be used in the case of hardwoods.

(b) Bolts for strays

Bolts shall be galvanized steel bolts of the required length and diameter, which shall not be less than 12 mm. All the necessary bolts, together with nuts and washers, shall be supplied with each post.

(c) Barbed wire

Barbed wire shall comply with the requirements of AASHTO M 280 or BS 1722 and shall be mild steel grade double strand uni-directional twist wire, each strand 2.50 mm diameter, for use at any height above ground. The wire shall be galvanized.

Barbs shall be manufactured from 2.0 mm (12 1/2 gage) galvanized wire and shall be spaced at no more than 150 mm.

(d) Gates

Gates shall be manufactured to the dimensions shown in the drawings or specified in the Bill of Quantities.

Gates shall be complete in every respect including hinges, washers, bolts and locking chain attached to the gate.

(e) Timber posts

Timber posts for holding down mats where the fence crosses streams, shall comply with the requirements AASHTO M280 or BS 1722 and shall be creosote impregnated.

(f) Manufacturing tolerances for wire

The actual diameter of wire supplied shall nowhere be less than the specified diameters by more than the following tolerances:

Specified diameter	Tolerance
1.0 - 1.8 mm	0.05 mm
2.0 - 2.8 mm	0.08 mm
3.15 - 4.0 mm	0.10 mm

9803 TYPES OF FENCING

The fencing shall be erected in accordance with the dimensions shown on the drawings.

Where existing fences have to be dismantled and re-erected, they should be re-erected either to the same design as originally constructed with such modifications as the Engineer may require or they shall be erected to one of the standards specified above, all as ordered by the Engineer.

9804 PROTECTION OF LIVESTOCK

From the time of the occupancy of the site until the date of the final maintenance certificate the Contractor shall take all measures necessary for the protection and control of livestock, etc., on the sections of the properties affected by his operations. He shall provide gates in existing fences cut by him for the purpose of access and shall ensure that all gates are kept closed during such time as they are not actually in use by his traffic.

Where alternative arrangements cannot be made the Engineer may direct the contractor to erect temporary fencing where necessary to protect livestock exposed to straying through his operations. Such fencing shall be of adequate standard and shall be erected ahead of construction operations. The fencing shall be maintained in good order during construction operations and on completion of the work it shall be removed from Site and all surfaces restored. The Engineer may order that any permanent fencing which is required be erected ahead of construction operations, where this is practicable, in lieu of the erection of temporary fencing.

Payment for the protection of livestock excluding the erection of temporary fences shall be included in the amount tendered for the Contractors Establishment on Site as specified in Division 1300.

9805 CLEARING OF FENCE LINE

The fence line shall be cleared over a width of at least 1 m on each side of the center line of the fence and surface irregularities shall be graded so that the fence will follow the general contour of the ground. Clearing shall include the removal of all scrub, stumps, isolated loose boulders or stones and other obstructions, which will interfere with proper construction of the fence. The bottom of the fence shall be located a uniform distance above the ground line in accordance with the requirements shown on the drawings. All material removed shall be burnt or disposed of in disused borrow pits.

Any area outside the road reserve, where clearing is not permitted by the owner or is not practicable, shall not be cleared if so directed by the Engineer.

9806 INSTALLING POSTS AND STANDARDS

Straining posts shall be erected at all ends, corners, and bends in the line of fences and at all junctions with other fences. Straining posts shall not be spaced further apart than shown on the drawings. The length of posts above ground shall be such that the correct clearance between the lowest wire and the ground can be obtained.

Posts shall be accurately set in holes and where shown on the drawings provided with concrete bases to the dimensions shown on the drawings.

Corner, gate, end, and straining posts shall be braced by means of strays or anchors as shown on the drawings or as directed by the Engineer. Gateposts shall not be used as straining posts but at each gatepost a straining post shall be placed as shown on the drawings and stayed.

Standards shall be firmly anchored into the ground at the spacing shown on the drawings or as directed by the Engineer. The spacing of standards between any two straining posts shall be uniform and not greater than shown on the drawings. In rock or hard material standards shall be either driven or set in holes drilled into the rock. The size of drilled holes shall be such that a tight fit is obtained. Care shall be exercised when driving standards to prevent buckling or damaging them.

All posts and standards shall be accurately aligned and set plumb. After posts and standards have been firmly set in accordance with the foregoing requirements, the fence wire shall be attached thereto at the spacing shown on the drawings.

9807 INSTALLING WIRE

All fencing wire shall be wired to the sides of standards or posts to prevent the wires from being displaced or becoming loose. The wire shall be carefully stretched and hung without sag, and with true alignment, care being exercised not to stretch the wire so tightly that it will break, or that end corner, straining or gate posts will be pulled up.

Each strand of fencing wire shall be securely fastened in the correct position to each standard with soft galvanized binding wire. The binding wire for each horizontal fence wire shall pass through a hole or notch in the standard to prevent slipping of the fence wire in a vertical direction, while the ends of the wire shall be wound at least four times around the fencing wire to prevent it moving in a vertical direction.

At end, corner, straining and gate posts the fencing wire shall be securely wrapped twice around the posts and secured against slipping by tying the end tightly around the wire by means of at least six snug tight twists.

9808 CLOSING OPENINGS UNDER FENCES

At ditches, streams, drainage channels or other hollows where it is not possible to erect the fence so that it follows the general contour of the ground, the Contractor shall close the opening under the fence by means of horizontal barbed wires at distances of 150 mm from each other, stretched between additional posts or straining posts as shown on the drawings or directed by the Engineer.

9809 EXISTING FENCES

Where a new fence joins an existing fence whether in line or at an angle, the new fence shall be erected with a new straining post positioned at the terminal of the existing fence.

Existing fences that are required to be taken down or moved to a new location shall be dismantled. Material not required for re- erection or declared unsuitable for re-use shall be neatly stacked at approved locations in accordance with the Engineer's instructions. Fencing wire or netting shall be stacked clear of the ground.

In the case of fences that require moving the Contractor shall re-use all material, declared suitable for this purpose by the Engineer, plus such new materials as may be required to re-erect the fence to the standard specified for new fences. The Engineer shall not be responsible for any delays or costs arising from breakage of reused wire during straining.

9810 INSTALLING GATES

Gates shall be installed at the positions indicated by the Engineer. The gates shall be hung on gate fittings in accordance with the requirements shown on the drawings. Gates shall be so erected as to swing in a horizontal plane at right angles to the gateposts, clear of the ground in all positions. At pedestrian and security fences the double swing gates shall not leave a gap of more than 25 mm between them when closed and other gates shall not be further than 25 mm from the gate post when closed.

9811 GENERAL REQUIREMENTS

Fencing, either new or repositioned, shall be placed alongside the new road reserve in areas where any existing fence will be removed or disturbed by the Works.

The completed fence shall be plumb, taut, true to line and ground contour, with all posts, standards, and strays firmly set. The height of the lower fencing wire above the ground at posts and standard shall not vary from that shown on the drawings by more than 25 mm. Other fencing wires shall not vary by more than 10 mm from their prescribed relative vertical positions.

Where temporary fences are erected they shall be firm and of sufficient height with a sufficient number of wires to prevent the passage of stock.

The Contractor shall, on completion of each section of fence, remove all cut-offs and other loose wire or netting so as not to create a hazard to grazing animals or a nuisance to the owners of the ground.

9812 MEASUREMENT AND PAYMENT

Item 98.01 Fencing .....kilometer (km)

The unit of measurement for the kilometer of fence line completed, measured along each fence line.

The tendered rate shall be in full compensation for the clearing of the fence line as specified, procuring, furnishing, placing and fixing all materials including posts standards and barbed wire.

Item 98.02 New gate (size and type indicated)..... number (No)

The unit of measurement shall be the number of new gates erected.

The tendered rate shall include full compensation for the procuring and furnishing of all materials, including gates, gate posts, hinges, bolts, concrete and straining wire, and the erection of the gates as specified and as shown on the drawings. It shall not include for any fencing wire erected on the gate.

Item 98.03 Moving of existing fences and gates:

(a) Fences .....kilometre (km)

(b) Moving of gates. ..... .number (No)

The unit of measurement for moving existing fences shall be the kilometer of fence and the quantity shall be taken as the length of fence which is permanently erected using material arising from fences which have been dismantled elsewhere. The unit of measurement for moving of gates is the number of gates moved.

The tendered rate for each kilometer of existing fence moved, or for each existing gate moved shall include full compensation for dismantling old fence, coiling and stacking of material not suitable for reuse, moving of all material, including posts and wire and the re-erection of the fence or gate in the new position and the provision of binding, tying and straining wire.

The tendered rate for each gate moved shall include full compensation for taking down the gate and re-erecting it where required including all new bolts, nuts and other accessories required but excluding new gate posts.