VIMC Extension

Specifications: Civil Engineering
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1. General specifications

The specification provided should be considered as general guideline and explanation about the needs of permanent circuits. Specific items may not apply as described to the needs of an individual project.
1.1. Glossary of Circuit facilities

1.1.1. Areas and pavement

Track areas and pavement
- Paved run off
- Run offs exterior of curve
- Run off (gravel bed)
- Infield (turfing)
- Stabilized grass interior of curve
- Verge (stabilized grass)
  - Grass grid
  - Artificial grass

Lines of protection, extraction and rescue
- Service roads
- Guard rails
- Access road extraction
- Tyre barriers
- Conveyor belts
- FIA debris fences
- Run off (gravel bed)

1.1.2. Pitlane

Different zones of pit lane with particular functions
- Fast lane
- Safety lane
- Pit wall
- Working lane
- Pit building
1.1.3. Marking, Painting

Picture shows: marking and protection lanes

Picture shows: marking start/finish straight
1.2. Concept of the Layout

The plot to be built on is located on Vancouver Island, British Columbia, Canada. The island is 460 kilometres (290 mi) in length, 80 kilometres (50 mi) in width at its widest point, and 32,134 km² (12,407 sq mi) in area.
The property has a size of 43 hectares and is located about 7 kilometres (4 mi) northwest of Duncan and about 50 kilometres (31 mi) north-west of Victoria, the capital of British Columbia. It lies in the east of the Cowichan Valley directly next to the Cowichan Valley Highway (18). The valley is the home of a growing number of vineyards and wineries. The warm, dry summers and mild, moist winters make this area part of Canada's only maritime Mediterranean climate.

The total area is a test- and presentation facility for the automotive sector. In addition to its testing and presentation possibilities, the facility also offers opportunities to carry out driver trainings, incentives and driving experiences. Whilst adhering to the highest safety and environmental standards the course also combines challenging aspects that at the same time are implemented in an appealing and natural atmosphere.

Taking sustainability and environmental issues into account, a concept was pursued, not only to provide a cost-efficient but a highly sophisticated facility in terms of driving skills. The implemented short cuts allow many different variants with diverse characteristics.
beginning from highspeed configurations up to high technical layouts.
The paddock and parking area include a dynamic zone with different driving modules.
Using this concept with a minimum of space requirements, it will allow the operator to host numerous events. It is also possible to integrate the circuit itself to the dynamic area and use the topographical situation as an additional driving module. Besides driving events, this complex can host theme fairs and trading events.

All elements consider a cost efficient, manageable and sustainable operation. This principle was an important guideline and orientation during the whole planning process.

1.2.1. Characteristics

A pure test and presentation facility (not designed for international racing).
The safety lines and run-off areas guarantee maximum security for all drivers. In addition to classic gravel beds paved run-off areas are intended which have no serious impact on the vehicle in emergency situations. Thus, the facility is also well suited for inexperienced drivers.

- length of the main course: 3,468m
- maximum altitude: 145,30m
- maximum fall: 9,9%
- maximum rise: 10,6%
- length start-finish-straight: 255m
- road width: 12m (14m at start/finish)
- turns: 17
- left turn (anti-clockwise): 8
- right turns (anti-clockwise): 9
- paddock area: approx. 2,790m²
- number of short-cuts: 4
- possible combinations: 6 (at least, combined with Phase 1)
- extremely lively topographic conditions
- hanging and banked turns in all areas
- high speed uphill driving
- highest driving skill demands
- smooth running circuit including various tight turn combinations

1.2.2. Possible Uses

Drift Training
The course is not only suitable for testing tires and the fine-tuning of electronic driving assistance but also offers the opportunity to perform drift trainings. In a safe environment, away from the public roads, the drivers can either improve their driving skills or simply just focus on the fun of driving itself.

Industrial Tests
The main route is ideal for testing suspension, braking and driving components. The industry will have a facility that also meets the confidentiality requirements, for example, to be able to test new models and prototypes.

Driver Training
Today, premium manufacturers such as Mercedes, Porsche, BMW and Audi, just to mention some of them, not only offer their customers vehicles with the highest quality, but also put the driver into focus as well. When buying a middle or upper class vehicle, the customer simultaneously receives a training course. The main course is ideal to implement this so-called “driving experience”.

Presentation
A lot of TV broadcasters, print magazines or advertising agencies rely on high-quality images. As the facility is integrated into nature, countless visual varieties are possible. At the same time the concept of the facility allows for a low-cost option to offer images and films to this target group. The building next to the circuit additionally offers an area to present cars to an exclusive group of visitors.
2. Main rainwater pipes

2.1. General

A circuit has extended requirements to the surface drainage system, mainly focused to the inlets, manhole covers, valves or any other facilities that impact the homogeneous surface of the asphalt. The strong requirements are derived from the cars itself. They have only a little of ground clearance and could potentially impact with a coverage in case of any level difference to the surrounding asphalt. Further the depression as a result of the aerodynamic forces below the car is able to pull off manhole covers or any other facilities when the car passes. Therefore, it is necessary either to remove any visible utility to the area outside the road edges (preferred solution) or to bolt every facility within the road edges to secure that it cannot be pulled off.

2.2. Main rainwater pipes

There is no restriction for the pipe material as far as the chemistry of the drainage water is concerned. The water generally does not contain any harmful components which have an effect on the suitability of materials.

All applied pipes have to meet the Canadian and local standards. Especially according to quality of material, static stability, water tightness of material and connection joints a quality standard is required and has to be verified by the contractor respectively by the manufacturer. Overshooting the indication of suitability according to the static stability under consideration of the loads and the construction method has to be provided by the contractor respectively by the manufacturer for each case of use.

Possible pipe materials are listed below without entitlement to integrity:
- Pipes of concrete
- Pipes of GRP (glass fibre reinforced plastic)
- Pipes of SW (stoneware) or PP (polypropylene)
- Pipes of HDPE (high-density polyethylene)

The concept of pipe laying presented and recommended herein were developed as quality control for works relating to underground pipe laying in open trenches. Nevertheless, the quality and the long-term fitness for use of the drainage system depends not only on the quality of the pipe material but primarily on the quality of installation work. So, it is essential that the work will be done by qualified skilled worker.

**Note:**
Specifications, requirements and recommendations pertaining to works not included shall be taken local specifications – civil works.

If there are different statements in the user instruction of the manufacturer they will overrule the corresponding part of the following instructions.

In any case, all requirements of the above-mentioned prior releases must be fulfilled.

For economic reasons, the fall of the pipes should follow that of the road.

The main pipe system will be designed with an adequate incline to ensure a free flow of the water.

*Pictures shows: Prefabricated manhole bottom and prefabricated concrete pipes.*
The manholes of the main pipe system should be made of concrete as well, possibly build with prefabricated elements or brickworks.

The load classification has to be designed for heavy load traffic; further each manhole has to be equipped with a galvanized silt box.

If the manholes are located in the verge area next to the road, they have to be covered with min. 30cm topsoil respectively the built-in material. In case the covers are located in the run off area of the circuit, which means in asphalt surfaced area, the covers have to be screwed.

*Pictures shows: manhole covering for heavy load traffic and silt box beneath covering for catching solids*

### 2.3. Cleaning Facilities

Due to different kinds of impurity cleaning facilities may be required in accordance with the environmental authorities and the local standards.

Additionally, petrol and oil interceptors with coalescence units can be installed where the
areas are particularly at risk for being soiled. The construction of the oil interceptors has to be designed in accordance to the accompanying catchment areas. Therefore the oil interceptors can be built as prefabricated constructions, or particularly as special clarification tanks.

The requirements of these cleaning facilities have to be advised in accordance with the existing treatment devices and the requirements for official approval.

Pictures shows: samples for prefabricated oil interceptors

2.4. Rainwater U- and slot-drains

GENERAL

The U-drains will be installed along the road, in run-offs, along the pit wall and paddock area in order to discharge surface water from highly paved areas. Cutting of U-drains has to be avoided and is not allowed along the road. Supplier should provide layout plan showing usage of 1000mm and 500mm units to avoid cutting. The gap width between the units should not exceed the dimension of 5mm. If the U-drain must be cut to length the remaining cover should be locked with 4 bolts at least. Minimal load classification as per BS EN 124 class D400 (heavy load is needed). Inlets for the above specified drainage channel have to be installed in accordance with the hydraulic analyse in a sufficient distance to each other. To guaranty the high requirements
of quality we recommend using companies with worldwide experiences, especially on circuits. Comprehensive product information for proposed type of u-drains has to be submitted along with the bid, samples to be provided as well.

**U-drains along circuit / in run off areas**

Load Classification BS EN124 / DIN EN1433 D400
Channel system extent of Body and removable 8-time/m bolted grid Covering
Body made of: fibre reinforced concrete or polymer concrete or glass fibre concrete with built-in frame (galvanized steel or ductile iron)
Cover to be ductile iron grid covering with bolts, spacing of grid max. 20mm (max. spacing of 20 mm is also not allowed to be exceeded by gaps at joints as a result of laying in turns!)
Units of 500mm for bounded areas – turns.
Appropriate Sink units with silt trap.
Appropriate end caps.
The current top level difference of 3-5 mm between the top of the U-drain and the surface and slope of the asphalt has to be secured.
Just before the laying process of the wearing course the U-drain edges and the supporting concrete surface have to be continuously painted with special coating in order to achieve a tight joint between the U-drain and the asphalt – supplier to provide coating or to specify requirements, technical support at site.
Cutting of U-Drains on construction site is not allowed.
Picture shows: U-drain NS100 specifications

Pictures show: U-drain along road edges

Slot-Drains along circuit, in front of positive Kerbs

Load Classification BS EN124 / DIN EN1433 D400
Channel system extent of Body and asymmetrical slot top
Body NS150 made of: fibre reinforced concrete, polymer concrete, glass fibre concrete, or plastics of PE/PP with built-in frame
Slot made of galvanized steel, open spacing of max. 20mm, height min.200mm (see Kerb Detail)
Thickness of galvanized steel walls min. 2mm; minimum no. of spacing stays within the slot 1000mm/8pieces, 500mm/4pieces necessary
Units of 500mm for bended areas – turns
Appropriate prefabricated sink units with silt trap with built-in frame (galvanized steel or ductile iron) for revision and discharge to be provided
Cover to be ductile iron grid covering with bolts, spacing of grid max. 20mm, alternative closed cover, 4-time bolted

**Typical Section**

**U-drain crossings at Service Roads**

Load Classification BS EN124 / DIN EN1433 D400
Channel system extent of Body and removable Covering
Body made of: fibre reinforced concrete or polymer concrete or glass fibre concrete with built-in frame, frame material according to Load Classification
Cover according to Load Classification, easily and comfortable to open/close without requirement of special tools
U-drain open at both ends (without end caps) with special (concrete built in situ) access for cable
One horizontal inlet facility (opening with integrated PVC-U-pipe and gravel package) within body area to be provided to allow discharge of surface water without sink unit

U-drains within Paddock Area
Load Classification BS EN124 / DIN EN1433 D400
Channel system extent of Body and removable Covering
Body made of: fibre reinforced concrete or polymer concrete or glass fibre concrete with built-in frame, frame material according to Load Classification
Cover according to Load Classification, easily and comfortable to open/close without requirement of special tools
Cover to be high class finished surface, good-looking for VIP purpose (coated or varnished with long life fastness)
All T-, L- and Cross- junctions have to be special units (prefabricated fittings) without cover frame at the junction area (body) to allow easily cable laying once the cover has been removed, stability of closed cover to be ensured as well
Appropriate Sink units with silt trap
Appropriate end caps

U-drains within Broadcast-, TV-Host Compound Area
Load Classification BS EN124 / DIN EN1433 D400
Channel system extent of Body and removable Covering
Body made of: fibre reinforced concrete or polymer concrete or glass fibre concrete with built-in frame, frame material according to Load Classification
Cover according to Load Classification, easily and comfortable to open/close without requirement of special tools
Cover to be high class finished surface, good-looking for VIP purpose (coated or varnished with long life fastness)
All T- L- and Cross- junctions have to be special units (prefabricated fittings) without cover frame at the junction area (body) to allow easily cable laying once the cover has been removed, stability of closed cover to be ensured as well

Appropriate Sink units with silt trap
Appropriate end caps

Architectural: U-drains at Building entrance way (pedestrian load)

Load Classification BS EN124 / DIN EN1433 A15
Channel system extent of Body and removable Covering
Body made of: fibre reinforced concrete or polymer concrete or plastics of PE/PP with built-in frame, frame material according to Load Classification
Cover according to Load Classification, easily and comfortable to open/close without requirement of special tools
Cover Material: galvanized steel, alternative plastic
Cover Type: slotted grating or grating with longitudinal bars or mesh grating or perforated grate
Appropriate discharge openings for drainage pipe connection
Appropriate Sink units with silt
Appropriate end-caps closed

Architectural: U-drains at Building entrance area where heavy load is expected (Technical Room, HV/MV Rooms etc)

Load Classification BS EN124 / DIN EN1433 D400
Channel system extent of Body and removable Covering
Body made of: fibre reinforced concrete or polymer concrete or glass fibre concrete with built-in frame, frame material according to Load Classification
Cover according to Load Classification, easily and comfortable to open/close without requirement of special tools
Cover Material: Cover to be high class finished surface, good-looking for VIP purpose (coated or varnished with long life fastness)
Appropriate Sink units with silt trap
Appropriate end-caps closed
Architectural: U-drains at Pit entrance (paddock area) for cabling installation in floor slab

Load Classification BS EN124 / DIN EN1433 C250
Channel system extent of Body and removable Covering
Body NS100 flat made of: plastic (HDPE) or steel
Cover according to Load Classification, easily and comfortably to open/close without requirement of special tools
Cover Material: galvanized steel or plastic
Max. construction height 80mm

Architectural: Slot-Drains in front of Main Grandstand entrance area (heavy load)

Load Classification BS EN124 / DIN EN1433 D400
Channel system extent of Body and slot top
Body NS150 made of: fibre reinforced concrete, polymer concrete, glass fibre concrete, or plastics of PE/PP with built-in frame
Slot made of galvanized steel, open spacing of max. 20mm, height min.200mm
Thickness of galvanized steel walls min. 2mm; minimum no. of spacing stays within the slot 1000mm/8pieces, 500mm/4pieces necessary
Appropriate Sink units with silt trap
Appropriate end-caps closed

2.5. Sewage System

The buildings must be connected according to their sanitary facilities to the sewage water pipe system. The amount of the sewage water to be discharged is calculated due to the kind of use of the building.

According to building and accompanying sanitary equipment the expected amounts of sewage water are calculated in dependence of the persons to be expected at driving events. The least nominal width of the pipes of NS 200 is mostly with low connection amounts, nevertheless, enough without reaching the entire capacity of the system. In addition, this nominal width for hydraulic reasons is not to be reduced and has to be according to the local guidelines and national codes.
In the paddock area all buildings are have to be connected to the sewage water system. In addition, the Supply manholes in the Paddock area have also to be connected there. Ascertained by the peaks of the sewage water amount in dependence of the respective driving event nominal widths up to NS 250 are also necessary in some areas.

**Main pipe system**

The specifications of the rainwater system specified above are applicable for the sewage water system and have to be kept. Further there is no restriction for the pipe material as far as the chemistry of the sewage water is concerned. The water generally does not contain any harmful components which have an effect on the suitability of materials.

All Elements of the main pipe system have to be installed according to local guidelines with appropriate bedding, adequate filling material and careful compaction. Particularly in paved areas any settlements caused are not allowed regarding the evenness of the final asphalt course.

**Discharging points**

The treatment of the sewage water is not scope of this project, so the connectivity to an existing treatment plant is premised. The sewage pipes of the circuit, buildings and paddock area will be connected to the public sewage pipe system and discharges to the treatment plant.

### 2.5.1. Rainwater Pumping Stations

In case of a tunnel (e.g. for access to the infield), a pumping station serves for the drainage of the tunnel during rainfall events. Construction can be realized by prefabricated concrete elements and the requirements concerning the pumping station have to be in line with the local construction codes. Besides, the pumping station must be provided with electricity supply and also ventilation facilities. To allow easy entry at the pumping station a leader has to be fixed as an entrance help with a fall protection.
Any backflow of the rainwater into the pumping station has to be prevented, so the invert level of the final pipe at the pumping station has to be arranged accordingly. The technical equipment contains two in parallel switched vertical diving power pumps. By this way the efficiency of the pumping station can always be maintained, regardless whether a pump has to be replaced.

In addition, the operation volume can be nearly doubled with simultaneous operation of both pumps.

2.6. Pipe laying process of gravity sewers for drainage and sewage systems

2.6.1. Preliminary Notes

The concept of pipe laying presented and recommended herein were developed as quality control for works relating to underground pipe laying in open trenches. Nevertheless, the quality and the long-term fitness for use of the drainage system depend
not only on the quality of the pipe material but primarily on the quality of installation work. So, it is essential that the work will be done by qualified skilled worker.

**Note:**
*Specifications, requirements and recommendations pertaining to works not included shall be taken from local specifications – civil works.*
*If there are different statements in the user instruction of the manufacturer they will overrule the corresponding part of the following instructions.*
*In any case, all requirements of the above-mentioned prior releases must be fulfilled.*

### 2.6.2. Pipes

All applied pipes have to meet the Canadian and local standards. Especially according to quality of material, static stability, water tightness of material and connection joints a quality standard is required and has to be verified by the contractor respectively by the manufacturer.

Overshooting the indication of suitability according to the static stability under consideration of the loads and the construction method has to be provided by the contractor respectively by the manufacturer for each case of use.

*Possible pipe materials are shown on the following images without entitlement to integrity:*

- Pipes of concrete
- Pipes of GRP *(glass fibre reinforced plastic)*
2.6.3. Handling of pipe material on site

Delivery, unloading and storage of pipe material have to meet the user instruction of the manufacturer.

All pipe material has to be handled with care. Only suitable lifting equipment as ropes, belts and pipe gripper have to be used.

Mechanical stress by bumping, falling down, rolling or trailing along the ground is inadmissible.

All construction elements have to be stored in a minimum distance of 60 cm to the edge of the trench in a way that damages will be avoided.

Before installation every pipe element has to be proved visual about its regular condition. Defect material is not allowed to be installed.

Gasket surfaces of bells or collars and spigots have to be clean as far as sealing elements like rubber gaskets have to be clean.

Inappropriate discharging handling equipment can damage the joints, thus causing leakages.
Never correct an incorrect pipe placement by pushing on pipes using heavy equipment.

Avoid concentrated or point loads on pipes.

3. Pit lane, Pit wall

3.1. Pit lane

Via the pit lane, drivers will be leaded to pit stop in front of the garages. The pit lane is divided into three parts:
- the fast lane to enter and exit pit lane
- the safety lane, crossing zone from driving area to pit stop
- the working lane, where the pit stop will be carried out by the teams
3.1.1. Fast lane

The fast lane including the safety lane will be paved out of the same asphalt mixture which will be used for the main roads (please refer to the specifications of the asphalt mixture for the road) and all requirements such as evenness, mixture, compaction etc. has to be secured as well.

3.1.2. Safety lane

In between fast and working lane is arranged a (coloured) safety stripe of 1 m width, marked with white lines in order to separate driving cars from working staff at pit stop.

3.1.3. Working lane

In the working lane tyres will be changed, fuel will be backfilled, carried out by the driving teams while pit stop. From the working lane, you have a direct access to the pits as well. Concrete slabs will be used for the working lane in order to retain possible fluids which can be dangerous such as fuel, hydraulic and provides a better resistance in case of fire in respect to an asphalt surface.

A minimum thickness of 22 cm for the concrete slabs has to be secured under consideration of the crushed stone sub base, in general. Further a less dimensioned reinforcement mat should be provided to prevent cracking of the concrete on the surface. The roughness (SRT, Skid Resistance Test value > 65) and the evenness criteria of the concrete surface for the working lane should have the same requirements as specified in the asphalt specification for the wearing course construction. A special treatment just after the already poured concrete surface with a triangular brushing (grid brushing) or the preparation of the surface after construction (blending of the surface) should be considered in order to achieve the required grip conditions (roughness value).

3.2. Pit wall

The pit wall separates the circuit from the pit lane. The pit wall is built for protection purposes and also for the teams to inform the drivers with technical data and instructions.
The layout of pit wall should follow the FIA regulations and the construction drawing. It should be 1.35 m high (from the road side) with an adjacent platform on the side of the pit lane. The platform should be elevated approx. 35 cm above the pit lane level.

The concrete construction will be used as
- platform for commando stands of the teams,
- platform for podiums, such as starters’ podium, photographer podium and
- foundation slab for the start light gantry.

**SECTION A-A**

3.2.1. Construction details

The pit wall is built as a reinforced concrete structure to withstand an impact force based on the speeds of the cars.

In case of the authoritative impact load, the load distribution from the reinforced concrete structure into the ground has to be guarantee by the allowable soil pressure and the accompanying sliding stability.
At the end and the beginning of the pit wall, the platform is lowered as an underground element in order to absorb the impact load of a car which would crash even in the endings of the wall. The load will be distributed by the continuous reinforcement into the underground slabs (length approx. 8m); the upper area of these slabs will be enough protected by a triple guardrail.
3.2.2. Drainage manholes in the pit wall platform

Regularly on one side of the pit all a drainage system is required to drain off the surface water from the pit lane.

As manhole covers should not appear in road and pit lane areas, the laying of this drainage
pipe under the pit wall cannot be avoided. So, the U-Drains have to be connected with a rainwater pipe located underneath the pit wall with enough covering regarding the required foundation of the pit wall.

Considering the manholes are located in the pit wall platform, their opening has to be built during the concrete works of the pit wall platform according to the Detail Drawings. The manhole covers need to be flush with the pit wall platform.

Manholes within the pit wall platform
3.2.3. Pit wall installations

Within the pit wall electrical and electronic installations will be needed. For events additional temporary cables will run from the pits to the pit wall and alongside the pit wall for broadcasting, timing and other purposes.

To get those temporary cables installed fast and easily without destroying the pit wall and pit lane, suitable conduits will be installed crossing the pit lane from the pit garage to the U-drain in front of the pit wall elements. The U-drain serves for both, for cabling and drainage purpose and provides connection to the conduits preinstalled into the prefabricated elements. All in all, there are over 100 duct connections from the pit building crossing the pit lane with different diameters.

From each pit, three cable ducts should be laid to the pit wall as shown in the construction drawing. Two ducts with 50mm flexible PVC pipe for permanent cabling (one for power cables, one for other cables) and one duct with 150mm PVC-pipe will run to the cleanout/manhole in front of the pit wall, through the platform straight to the sockets temporary attached to the wall.

The latter duct should be used from the teams to run their temporary cables to the pit wall. The bends in these ducts should be limited to 15 degrees allowing pull cables easily. Inside the wall the diameter of this cable conduit should be reduced to maximum 110mm.
Further the conduits must be protected with suitable coverings to prevent the conduits getting dirty on the one hand, but ensuring an easy access for pulling the cables through on the other hand.

*Needed electrical wall sockets etc. installed temporary*

### 3.2.4. Opening in pit wall

In face of the circuit control respectively the Finish Line, a wall opening for a photocell is required to install a light beam for time keeping.

*Pit wall with wall opening for photo cell and loops cut in the asphalt*

### 3.2.5. Gate in pit wall

Pit wall gates are opening elements between the pit lane and the circuit to enable drivers and cars to escape from the circuit. A minimum of two pit wall gates are required at the start-finish straight for both: permanent or temporary walls.
Pit wall gates

The gates should be installed at the pit wall with suitable bolts. They have to be flush with the side of the pit wall facing the road and resistant against the impact design loads. Gaps to the pit wall and the ground should not exceed 20mm.

Front side and back side view of the gate

The gates should be produced as steel structure with high-grade steel in accordance with static and structural requirements as shown in the drawing, to be transported to construction site, unloaded and installed.

The gate is mounted with a heavy hinge-construction which is fixed on the steel frame as shown on the pictures below:
3.2.6. Pit wall debris fence

The pit wall has to be equipped with a protection fence on the top of the wall which has to be installed as per construction drawing. The protection fence has a height of approx. 2.00 m above the pit wall top level and the top 40cm of the fence are angled with 45 degrees towards the road.

The protection fence can either be delivered already pre-mounted to the pit wall elements or alternatively fixed after mounting the pit wall elements on site.

All parts should be hot-dip galvanized with layer thickness of 80 µm.

The elements of the protection fence are dimensioned as follows: length 2,90m with a distance between each element of 0,50m, enabling the team to keep their driver informed during the ride with signal boards.

Fence elements and scope of works:
Construction of the post, 40x60mm, with a distance between each element of 0,50m.
Bracing with additional elements, 40x40mm, twice on the top of the fence and one at the bottom as well.

Base plate for fixing the fence on the pit wall. This base plate has to be installed during concreting.
Fixing elements, 30x50mm, including necessary bolts.

Tensioning between each fence element with threaded rod 12mm. Mesh wire, max. Mesh-size 100/100 mm, wire thickness 5 mm. Each pit wall gate has to be equipped with this protection fence as shown on the referring “Typical Detail” drawings.

Pit wall with fence on the top

3.2.7. Railing on platform of the pit wall

The railing on top of the pit wall platform should be installed as a safety requirement with appropriate spacing of 1.00m between the single elements to walk through.

The railing should be made of steel, hot-dip galvanized, in accordance with construction drawings.

Height approx. 1.00 m.

Post spacing approx. 1.00 m

Diameter of the posts approx. 50 mm
Railing with galvanized steel tube, diameter approx. 50 mm

Production of openings of 1.00 m in width. Including mounting plate for dowel attachment to concrete surface and connecting and mounting elements in special steel.
Bolts and washers made of stainless steel

*Pit wall with protection fence and railing*
4. Protection areas, safety installations

4.1. Kerbs

4.1.1. Type of kerbs

The following types of kerbs are used:

- positive kerb, 25 mm height step (Vallelunga type)
  
  kerb section: 1000 mm x 800 mm, with 2 slopes in opposite directions (gradient 1:1 / 1:10) with a height step of 25 mm.

*bird view of a positive kerb alongside road edge*
prefabricated positive kerb and positive kerb line as built
- **negative kerb, 25 mm height step (Melbourne type)**

  kerb section: 800 mm x 1000 mm, with 2 slopes in opposite directions (gradient 1:1 / 1:10) with a height step of 25 mm.

  Behind the negative kerb a drainage line will be installed according to typical drawing with an stripe of artificial grass or grass crete. Due to the kind of drainage installation (U-drain or slot-drain) an additional 2\textsuperscript{nd} kerb can be required for equalizing the height step and protecting the drainage installation.
4.1.2. Details of construction

Kerbs reflect a boundary at the edge of the circuit following the driving line at the turn-entry, -inside and -exit. The construction with a concrete type of C35/45 = M40 may be executed by in-situ concreting or related production and installation of prefabricated elements.

Notice: The contractor should provide a mock-up (prototype) of all types of kerbs prior to construction for approval.
All kerbs have to be installed on suitable ground conditions as specified for the rack areas with sufficient compaction on top of the subgrade and concrete support.

The subgrade of the kerbs follows the gradient and cross fall of the road. All information about the necessary height steps for the different types of kerbs are related to the road cross fall line.

The surface of the kerbs has to be constructed absolutely even in conjunction with the road surface. The step allowance will be maximum 3 mm.

The run-off areas adjacent to the kerbs have to be adjusted exactly to the kerb levels and should also follow the steps of the positive and negative kerbs, in general.

The scope of works includes the construction of a complete concrete structure in accordance with the FIA guidelines. The concrete should be done cast-in-situ but pre-cast elements with sufficient quality can be installed as well.

The following construction items are included in the scope of work:
- Preparation of a static analysis, including construction documents. These are to be approved by the designer before construction.
- Earthworks, including the preparation of a smooth and compacted sub grade.
- granular subbase course, thickness 250mm, CBR=30 on top
- Shuttering and pouring of concrete.
- Finishing and smoothing of the surface and shoulders.
- Production of a vertical opening of approx. 0.2 m² at a spacing of approx. 5 m for the installation of the road inlets for drainage purposes.
- Sealing of construction joints with elastic material at intervals of 4 meters in case of in-situ kerbs only.
- In case of prefabricated kerb installation, the gaps between the concrete elements and road edge will be filled with high strength material such as epoxy or suitable concrete with additive.
- In hairpin turns the prefabricated elements has to be cut-off (adjusted) in regard to the radius of the turns.
- just before the laying process of the wearing course the kerb edges has to be continuously painted with binder coating in order to achieve a tight joint between the kerb and the asphalt.

The dimensions of the kerbs are:

- Width of each type according to the drawing (1000mm),
- Length as per layout drawing, to be confirmed before construction start.
- Thickness in accordance with static analysis, at least 200mm.

At the beginning of each kerb a terminal piece is required to make a smooth transition up to the width of the kerb. This terminal piece is made of in-situ concrete; a constructional reinforcement mat should be implemented to prevent cracks on the surface.
4.1.3. Verges

The area between the edge of the road (or kerb line) and run off areas have to be bordered all along its length by verges. The maximum width of the verges should be 3.0 metres subject to the breaking areas of the motorcycles according to the Master Layout drawing. They should be adjusted to the road and run off areas without any step, within an even surface and sufficient compaction.

Inside the verge the connection pipes of the kerb drainage and run off areas could be installed.

The topsoil of verges should not be more than 150 mm thick and should be seeded with suitable granular material. The topsoil should provide a good drainage function and should not get soft during wetness.
All installed manholes have to be covered, either with a minimum of 300 mm topsoil or with artificial grass.

4.1.4. Stabilized grass

The stabilized grass is a mixture of granules and topsoil as shown on the drawing below:

- mixture of topsoil, sand and crushed stone
- grain size crushed stone 0/16 mm or 0/8 mm, sand 0/2 mm, topsoil
- volume fraction crushed stone 50%, sand 30%, topsoil 20% incl. compost fraction of 100 l/m³,
- layer thickness of 20cm fitting and rolling
- fraction of grass seed approx. 25g/m²
- tolerance of design level +/- 1 cm

Regarding the arid climate conditions, alternative verges can be built with artificial grass as specified or usable turf grass.

4.1.5. Artificial grass

In the area between the negative kerb and the asphalt run off a verge of artificial grass with a width of 2,0m should be installed.

Further a 3,0m verge made of artificial grass could be used as an alternative verge.
protection instead of natural grass in case of dry climatic conditions in order to avoid any maintenance or irrigation.

The location of the artificial grass is shown on the layout drawings and has to be confirmed by the site management before the start of construction.

The artificial grass is made of polyethylene: there are artificial grass elements fixed on a base meshed mat.

The width of these artificial grass elements is about 1.0m, generally rolled up on sheets with a length of 15m.

The height of the grass is 22mm, with a support mat made of foamed polyethylene with a thickness of 10mm.

This composite construction can be used prefabricated or installed in situ according to the manufacturer’s devices.

Construction and scope of services:

- Construction of the concrete base support, concrete grade 30, thickness min. 15cm.
  Alternative base support: the artificial grass can be fixed on the roughen asphalt surface as shown:
VERGE
( artificial grass )

- Clean the concrete base surface respectively the roughen asphalt surface (remove dust, grit).
- Apply the adhesive, regarding of the sufficient time for short-drying
- Install the artificial grass mat when the adhesive is nearly dried
- Compact the mat with a roller
4.2. Non-paved run-off areas

The run off areas are part of the safety installations and are calculated in accordance with the FIA guidelines. They should allow a safe running off for the drivers.

Generally, the cross fall should follow to the direction of the run off area in the same slope. The vertical alignment of the run off area should follow the road gradient.

The surface can be executed with or without pavement. The following specifications are related to non-paved run offs.

4.2.1. Gravel beds

Inside of these run-off areas no steps are allowed and the gravel surface has to be produced as finish level according to the design levels. For every driving event the gravel run off has to be mixed or to be roughening to make sure that the gravel is not compacted.

In the lowest points of the gravel run off perforated drainage pipes has to be installed to guarantee a sufficient drainage. The soil should be compacted up to a CBR of 2-5.

Gravel of size 5/15 mm, round grain in accordance with FIA guideline, installation thickness 250 mm, to be installed after preparation of the sub grade. Prior to installation, a sample and the grain size distribution curve for the employed material has to be submitted for approval.

run off areas –gravel bed
4.2.2. Stabilized grass

Some run off areas are proposed for being made of stabilized grass. Detail specifications see chapter verges – stabilized grass.

Inside of these run-off areas no steps are allowed and the grassed surface has to be produced as finish level according to the design levels. Prior to installation, a sample of the mixture has to be presented for approval.

4.3. Protection line Tecpro and tyre barriers

4.3.1. Details of construction

The specification is to be read in conjunction with the relevant "Typical Detail". Tyre barriers have been shown to be an effective means of absorbing the energy of a vehicle in the event of a collision, significantly reducing the severity of the impact and therefore the risk of injury to the driver and damage to the vehicle.

New rejected tyres or second-hand car tyres with uniform diameter will be stacked to form a homogenous barrier, placed in front of and normally fixed to a permanent barrier. Completely worn tyres are not allowed; further the tyres are not allowed to be completely out of date. At least the kind of abrasion of the tyres should not exceed 20%, and the used kind of tyres should be presented for approval before construction works.

The tyre barrier must be at least as high as the permanent barrier (minimum 1 m), therefore following numbers will be required to achieve this height:

<table>
<thead>
<tr>
<th>Tyre width (mm)</th>
<th>pieces</th>
</tr>
</thead>
<tbody>
<tr>
<td>175</td>
<td>6</td>
</tr>
<tr>
<td>185</td>
<td>6</td>
</tr>
<tr>
<td>205</td>
<td>5</td>
</tr>
</tbody>
</table>
Tyre with a size of 175/65 R15 or 185/65 R15 are recommended as six layers of these types will achieve the necessary height. Other types may be used after approval. For smaller sizes, more tyres would be needed to achieve the height. The tyres forming each vertical stack must be securely fastened to each other, as must adjacent stacks. The method of fastening is to use bolts fitted with stiff nuts and large washers (diameter 40 mm).

The tyre barriers may be installed as 1-row, 2-row or 4-row type. The 2-row and 4-row types should be done with "six-packs".

4.3.2. 2-row and 4-row type

The 2-row and 4-row type are made out of six-packs, as these methods ensures a maximum protection in case of any impact.

The six-packs are mounted together with six single stacks of tyres. In the six-pack, the tyres in each layer of the stack should be bolted together with bolts as specified above.

One completely installed six-pack consists of 36 tyres and will need 234 bolts to be
One six-pack with tyres 185/65 R15 will be about 2.10m long and 1.30m wide. One mock-up should be done for approval before the production starts.

The six-packs should be secured to the guardrail and to each other using plastic strapping. The plastic strapping may be omitted in areas with conveyor belts (specification see below). Finally, the tyre barriers will be fixed with a plastic strap on the guardrail.

The 4-row type will be installed in the same way as the 2-row type, but with two lines of six-packs.

The production of six-packs should not be done in the circuit areas. The installation should be done at the last stage of the construction period. The tyre barriers should be painted after installation with suitable colour to be advised from the client.

4.3.3. Conveyor belt

In some turns a conveyor belt should be installed in front of the tyre barrier achieving an even higher safety standard. The location for the conveyor belts is shown in the drawings.

The conveyor belt should be bolted to the tyre barrier as shown in the detailed drawing with minimum 8mm bolts and minimum 40mm washers. The belt should be secured about 200mm into the ground; therefore minimum width of the belt should be 1200 mm.

The connection joints have to be 300 mm overlapped and bolted with a minimum number of 6 bolts.

The terminal pieces of the conveyor belts should be bolted to the guardrails.

The reinforced industrial rubber belt (400kp/cm) should be made in 3 textile inlays which
will have a minimum thickness of 12mm. Plastic materials are not allowed because of fire protection reasons. A sample has to be submitted for approval before construction work commence.

4.3.4. **Alternative Protection Barrier Tecpro**

Alternative to the described tyre barriers a new security system can be used. In accordance to the FIA regulations the Tecpro Company developed a new protection barrier.

Within the last years this system was not only tested on several circuits but was also tested in the laboratory by crash tests with very positive results.

The system consists of blocks with a shell of flexible and very resistant Polyethylene. The block is filled with expanded foam. The mass characteristics of the expanded foam are approx. 22kg/m³, while different stability stages can be used in reliance to their place of action.

The dimensions are as follows: length = 1,50m, width = 0,60m, height = 1,20m.
4.4. Protection Line Guardrails

The first security line is formed by a triple guardrail which should prevent that vehicles can crash uncontrolled and without breaking into the spectator's areas. This security equipment can be installed permanently or mobile.

The specification is to be read in conjunction with the relevant "Typical Detail" drawings. The location and technical details for triple guardrail must comply with the FIA and FIM international guidelines for motor racing circuits (construction issues and safety issues) and the construction drawings.

The barrier will consist of a triple guardrail of ribbed steel, placed along the outside edge of the verge, generally not less than 5 m from the road edge. The face of the barrier should be vertical, unless the verge rises from the road edge to the first line of protection, in which case the barrier face should be perpendicular to the plane of the verge.

Interior of curves
The barrier should be parallel to the trajectory and as far from the edge as the nature of the ground and the needs of the emergency service permit, in order to provide maximum visibility along. There should be correctly overlapped access points.

Exterior of curves
Measured from the outside verge-edge along the tangent to the edge at the beginning of the geometrical curve, there should be a run-off area, which has to be bounded by triple guardrails.

Construction and scope of services include delivery and installation of triple guard rails with all components and the necessary earthworks.

4.4.1. General specifications

All parts of guard-rail should be hot-dip galvanized (minimum coating: 305 gr/m2 = 1 oz/sq ft).
The connection of two sections of guardrail must always be made so that the surface presented to oncoming cars is completely devoid of projections or discontinuity.

The type of guard rails and their specifications have to be approved by the engineer.

Generally, before the contractors will go in production they have to provide a mockup of each typical detail for approval.

4.4.2. Rail elements

a) The standard rail elements are in rolled steel sheet meeting the following requirements:

- ultimate tensile stress: 42 kg/sq mm,
- thickness: 2.7 mm,
- moments of inertia: X-X 1248.7 cm4, Y-Y 96.1 cm4

Non-standard type rail elements should meet at least the above specified requirements.

b) Installation level:
The gap between bottom rail and top soil should not exceed 20 mm (maximum 30 mm).
4.4.3. Supports

a) Metal supports: should be in rolled steel, 120 standard profile U-NP 120 (U-section with reinforced angels, 120 mm wide).

They should be set directly into the ground without concrete to a minimum depth of 1.20 metre (more in soft ground).

However, in order to maintain the regulation height protruding above ground, it may be desirable to set some of the posts in concrete.

Bolts must be at least 16 mm (or 5/8 inch) diameter. Shear bolts must not be used.

Metal supports should not project above the level of the top guard-rail.

b) Spacing of supports: maximum 2.0 metre.

For non-standard types, all elements differing from the above specifications must be submitted for FIA approval.

4.4.4. Washers

Adequate washers must be used under bolt heads. The following specification is recommended, based on the standard Armco-type bolt.

Cut steel washer with a diameter of 45 mm (bolthole approx. 18 mm diameter), 4 mm thick.
If the bolt head is provided with an oval shoulder, a circular seat should be milled in the washer to fit it (2-mm deep, 29-mm diameter).

4.4.5. End sections

The end sections of guardrails should be reinforced. The end of each rail element must be provided with the standard curved terminal piece.
4.4.6. Guardrail openings

Openings for vehicle access and extraction must be provided where shown in the layout drawings.

Along the facility should be access points to allow the entry and evacuation of vehicles. The location of these access points should be established in consideration of the layout, service roads, observation posts and other installations. Basically, there should be an access point at one or the other side to the road at least every approx. 150 m. Where the access implies an opening in the protection systems this must be erected as follows:

a) The barrier following the opening forms an angle of maximum 3° (1 in 20) with the general line of the protection;

b) A straight line passing through the extremities of the barriers preceding and following the opening forms an angle of minimum 35° with the road edge, or with the tangent to the cars' extraction, where this tangent diverges from the edge towards the opening. This will ensure a sufficient overlapping of the preceding over the following barrier to protect the opening.
The cables, installed temporary on the back side of the guard rail, need a u-drain used as cable duct in order to cross the service road in guardrail opening.

A U-drain with grid with a minimum width of 100 mm diameter and above 6 m length, installed rectangular between each end sections of the rail line, makes it possible to cross over the cable line without running on cable directly.

Regarding the less amount of storm water being cached in these u-drains, there is no connection to the main pipe system required. The cached storm water inside of the u-drain will discharge at the end of each u-drain trough gravel packages (infiltration into the existing ground).

4.4.7. Triple guardrail sliding gate

To ensure an access for vehicles and to keep the safety devices mentioned above as well, a guardrail gate can be required.

According to the guardrail specifications the guardrail gate consists of a triple guardrail made of ribbed steel with a steel frame construction.
Further a concrete foundation with an anchored U-profile and guide rollers will ensure the mobility for the temporary opening of the gates. The fixing of the closed guardrail gate will be provided by mobile posts with securing bolts.

All parts of guard-rail gate should be hot-dip galvanized and constructed as shown on the drawing.

4.4.8. Single guardrails outside circuit areas

Alongside embankment areas within deep slopes, the edge of the (service) roads has to be protected by a single guardrail according to local standards. Other safety barriers according to local standards can be presented for approval.
Example of safety barrier (single guardrail)

4.5. Debris (FIA) Fence

The second security line consists of a special fence whose extremely reinforced construction is able to catch flying debris and therefore protect persons standing or sitting behind from the immense force of these parts. A fence capable of absorbing the shock produced by a car, of the maximum weight and at the maximum speed attained on that part of the circuit, leaving the road to the barrier.

Access points for marshals must be provided as per construction drawings. The FIA fence has a height of 2,70 m above ground level and has to be installed as per construction drawing. The top of the fence are buckling with 45 degrees towards the road. The lower 80cm of the fence can be free of any wires and a fence mat, so that drivers or marshals can pass the fence in this lower part easily.

All parts should be hot-dip galvanized with layer thickness of 80 μm.

Picture shows: FIA Fence 2,7m height
4.5.1. Fence elements and Posts

- Construction of end posts out of sectional steel, double U iron 120 (Moments of inertia of the Posts: X-X 864 cm\(^4\), Y-Y 318 cm\(^4\)) and intermediate posts out of sectional steel, U iron 120 (Moments of inertia of the Posts: X-X 364 cm\(^4\), Y-Y 43.2 cm\(^4\)).
- Posts to be planted in individual concrete foundation, grade 30, width 400/400 mm, depth 1000 mm. All end posts with supporting post as per construction drawing.
- The holes for fixing of the cables should be drilled before galvanising with a spacing of 250 mm in suitable diameters.
- The distance to the next post should be not more than 4,000 mm.

4.5.2. Mesh wire and bracing cable

- Bracing cable, 15-mm diameter, to be installed in 250mm spacing on the FIA fence posts.
- Single-cord multiwire cable, 22 mm, cable mounting tension 500 kg/cm\(^2\), to be attached to the posts in various lengths and braced, including anchoring with fitting, 110 x 45 x 10 mm, and 2 bolts, 35 x 12
- Installation of steel turnbuckles for 22 mm thick cables. All parts hot galvanised.
- Construction of wire mesh fence with a height of 2,700 mm, attached to the FIA fence. The mesh wire should be installed on top of the cables to ensure a proper load distribution in case of any impact.
- Wire mesh with heavy zinc coating, max. Mesh-size 90/90 mm, wire thickness 4 mm, production of corner and intermediate bracing and the necessary tensioning wires with turnbuckles. Tensioning wires 4mm diameter and heavy zinc coating.
- Upper and lower tensioning wire to be fitted in each mesh, centre tensioning wire to be fitted in every second mesh, if appropriate.
4.5.3. Stabilization fields

- Each end field of a separate fence needs a bracing profile or cables as reinforcing frame.
- In distances of 40 to 50 meters dependent on the local temperature conditions, an additional intermediate stabilization field has to be installed.
Generally, before the contractors will go in production they have to provide a mockup of each typical detail for approval.

4.6. Service roads

The service road and service areas will ensure the rescuing in case of any accidents or technical problems of a vehicle. In this way the ambulances and crane trucks are able to get on the circuit area quickly. Regarding that the service road has to ensure a direct connection to the medical centre from every point of the circuit.

The width of the service road is about 4,00m in general. For the purpose of achieving an appropriate surface, asphalt works are recommended as specified in the upcoming design stage.

4.7. Object protection (spectator) fencing

4.7.1. Spectator fencing

Behind the above-mentioned FIA-Fences an additional protection fence will be required.
The spectators or unauthorized people should be kept away from the dangerous area.

The protection fence has a height of 2,000 mm above ground level and has to be installed as per construction drawing.

Fence elements and Posts
- Construction of the steel posts: dimension 60/40/2 mm in rectangular tubes. The required foundation depth is minimum 800mm.
- The distance to the next post should be not more than 2,500 mm

Mesh wire
- Round bars galvanized metal wire mesh with max. grid-size of 50x200 mm has to be fixed at the posts. wire thickness 6 mm.
- Anchoring with a clamp (u-shape), dimension 9/20/9/2 mm as per construction drawing

4.7.2. Object protection fencing
According to the layout drawing the circuit area has to be protected against public access with permanent or mobile protection fences.

This protection fence has to be constructed in accordance with the local standards; particularly a protection against climbing-over has to be provided.
4.7.3. Gates

The access will be ensured by gates with a central locking system, for this reason sliding gates or revolving gates are proposed in accordance with the local standards.

5. Circuit Installations

5.1. Start light gantry

Viewable for all drivers the start-light gantry is installed at a bridge above the start-finish-straight. Here the start is indicated, but also other information via light signals can be transmitted like warnings or driving abort.
Rectangular to the driving course, a steel frame with span length of approx. 25.0 m is placed. One post with approx. dimensions of 0.6m x 0.6m is installed on the pit wall platform as shown on the construction drawings, the second one on a foundation slab.

5.2. Signage

The approach to a curve should be signalled by distance sign boards placed, as a rule, at 50m intervals from before the geometrical curve, and extending back to before the deceleration point. Their number and position should be determined according to the circuit layout and they should indicate the distance to the geometrical beginning of the curve.

5.3. Marshal Posts

The marshal posts are arranged all around the circuit and important information (e.g. no passing, oil on the road or break) is being transmitted by code flag signals or traffic light signals to the drivers.

The small buildings or tent structures should not only offer the marshals a secure refuge but all required security-equipment for fire fighting and flag signalling should also be stored there. Marshal posts shall be protected by an approved barrier. Adequate protection from stones and debris should be provided for example by the specified barrier solutions.
The distances between the marshal posts should not amount to more than 400 m in order to guarantee a visual contact between the marshals so that flag signals can be seen from one post to the next one.

The technical equipment of all Marshal Posts includes telephone or radio communication to stay in touch with the circuit control.
In service areas where space is limited the marshal post is often positioned right behind the protection barrier.
Apart from the openings in the protection barrier, service entries are placed in constant distances to provide rescue vehicle and medical access to the facility.

Fencewall and guardrail opening

Run-off areas also present these access points where additional mobile auto cranes or Manitous are positioned for fast vehicle rescue.
6. Marking and painting

6.1. Marking

6.1.1. Road edges
The edges of all circuit related road constructions have to be bordered all along its length with suitable anti-skid road paint.

The marking should be 15cm wide in a distance of nearly 5cm to the edge of the asphalted surface.

The scope of works includes all necessary preliminary jobs, such as cleaning and premarking.

6.1.2. Starting grid
The starting grid has to be marked according to the FIA-Requirements.

6.1.3. Pitlane entry, exit
The entry and exit of pit lane have to be additionally marked according to the FIA guidelines.

6.1.4. Border line pit exit - entry
In order to keep away cars from the driving line while leaving pitlane, a white border line separates pit out from circuit.

The lineout of pit entry and exit marking on surface will be obligatory requirement by the FIA during inspection.

6.1.5. Pitlane
In order to guarantee a safe pit stop, the different pitlane areas are separated by marking lines and a colored safety lane.
6.1.6. Pits

6.1.7. Pit-stop

The position to change tyres and refill fuel; temporary marked by the team.

6.2. Painting

6.2.1. Kerbs

All kerbs should be painted just before handing over the site to the client. The paint should be suitable reflective road paint (anti-skid). The colour will be decided later by the client. Usually, white and red will be used.

The different colored sections should alternate all 2.4m or every 2-3 kerb-elements according to their length.
7. Infrastructure - Cables, Conduits, Networks

The facilities operation needs a particular complex network of cabling for electrical and electronically purposes (power supply and data transfer). Additional (blank) conduits are necessary for other purposes, e.g. temporary cabling, further steps of circuit development.

7.1. Network alongside road

7.1.1. General

Installing cables/conduits alongside or crossing a circuit, the following items have to be considered for long-term safety of infrastructure:

All cables and conduits for Special Electronic should be at least 1.20m under surface level in order to avoid hidden damages by drilling or hitting posts (of fences or guardrails).

On top of all embedded conduits/cables should be a warning instruction, e.g. tape “heads up”, in order to avoid definitely damages by following earth works (cuts or ditches afterwards).

Before refilling ditches, all installations underground should be recorded by digital 3-dimensional surveying and saved by documentation “as-built”.

Sand filled ditches are collecting surface water. Sometimes this disadvantage is interfered with deep levelled manholes and high ground water level.

To keep the network strictly free of water and pollution, conduits and manholes should be connected sand- and waterproofed. Using special fittings like double plug sleeves, the coupling is tight to sand and together with a sealing ring waterproofed.
Closure plugs on each end of conduit, fitted as soon as possible, protect the network already while construction period covers on manhole as well.

Manholes in deep levelled areas should have pump sumps or should be connected to the drainage system by an opening in the slab and installation of a drainage pipe.

All bends should be as smooth as possible; elbow fittings should not exceed 15°. Flexible pipes allow bends in big or small radii.

### 7.1.2. Material

Appropriate to various vertical and horizontal alignments, to different strain forces and necessary bearing capacity, the conduits are made of rigid or flexible materials. Normally, cable conduits are made of PVC or PE tubing. The most usable diameter is 150mm, smaller or bigger sizes are taken if required. All diameters can be combined to single or multi-line layers.

By demand of strong load bearing capacity (in case of high compression loads, insufficient thickness of covering soil) conduits of PE-HD in twin-wall construction or cast and ductile iron or steel are suitable.

### 7.1.3. Installation

The conduits should be laid, embedded and covered with sand. If the installation level is situated in soft soil or underground water level, the package of conduits embedded in sand should be wrapped all around by geotextile.

Spacers and pulling strings/wires are helpful devices for the lay down of conduits and cable pulling.
7.1.4. Manholes

To pull cables round the entire circuit, manholes should be installed every approx. 50m in the conduit lines and on road crossings. They are generally situated behind guardrails inside the service road area, never at the edge of circuit or bordering safety zones left and right.

The manholes can be prefabricated as concrete units or made by brickwork. The minimum size is \( l/w/h = 800/800/1,000 \) mm; due to the amount and diameter of cables, they are bigger sized.

The manholes should provide suitable numbers of openings on each side to connect the conduits.

7.1.5. Circuit installations

Circuit operation and surveillance need a string of lightning and cameras around the facility.

These installations get connected to the cable/conduits network by small manholes and flexible ducts.

7.1.6. Screening devices

Combining power and data cables together in one trench or cable channel, a minimum distance and shield must be considered as electromagnetic screening in order to avoid interferences.
For lightning protection a galvanised round steel wire with min. diameter of 3mm should be inserted.

7.1.7. Temporary cabling

Temporary outdoor cabling and SE devices, in order to connect electronical installations around the whole facility to the circuit control. Where cables are crossing guard rail openings, they are laid in cable channels, otherwise outdoor on surface.

These cables are laid in U-channels at access point, where they are crossing the guardrail openings. For a quick and easy cable installation, the gratings should not be locked.

7.2. Network in pitlane

While driving and training sessions, circuit management and teams need a communication network from pits, circuit control and time keeping to pitwall. Cable ducts and channels serve as permanent or temporary cable routing for power supply and data transfer.

7.3. Network inside pitwall

7.3.1. General

The pitwall is platform for a lot of installations, such as command booths, starter podium, start light gantry. All these installations are connected among each other and with the pits. This network is realized by different cable ducts and channels inside the pitwall.

A lot of permanent electrical and electronic installations are managed on/from pitwall. While events additional temporary cables will run from the pits to the pitwall and along the pitwall for broadcasting, timing and other purposes.
To get those temporary cables quick and easy installed without damaging the pitwall and pitlane by drilling holes etc, the pitwall has two cable conduits along the wall.
7.3.2. Cabling for command booths

The command booths on pitwall get power supply and data from plugs, as permanent installation in the upper channel in pitwall. The corresponding cables coming from pitbuilding are installed in ducts crossing the pitlane with different diameters.

From each pit, three cable ducts should be laid to the pitwall. 2 ducts with 50mm flexible PVC pipe for permanent cabling (one for power cables, one for other cables) will run straight to the upper cable conduit.

One duct with 150mm PVC-pipe will run to the pit wall platform ending near the wall. This duct will be used from the teams to run their temporary cables to the pit wall. The bends in these ducts should be limited to 15 degrees allowing pull cables easily.

The upper cable channel will be used for permanent installation of power supply and telecommunications cabling inside the conduit. Each pit will require 4 power outlets and 4 video outlets on the pitwall. This channel will be permanently covered by a stainless steel cover with small openings in the area of the electrical facilities.

The lower channel, made by an angle shaped stainless steel guide (dimensions: width = 200 mm and depth = 100 mm) and installed and cast in place, will be used running temporary cables of the organisers, teams, broadcasters and FOM.

In areas of gates and openings, the cable conduit will run down to the platform, to the drainage duct, inside this duct to the other side of the opening and back to the conduit location. The main target is to be able to lay cables without need to pull through any opening.
7.3.3. Cabling alongside pitwall

The other different installations on pitwall are connected by permanent or temporary cable networking laid in the open channels or ducts.

Ducts inside the ground slab allow any connection between the different installations on pitwall.

7.4. Networks miscellaneous facilities

7.4.1. General

Facilities, such as paddock, broadcast centre, host TV compound have to be connected in network with the pit building. In case of temporary utilisation or special requirements cable channels are more efficient than ducts.

Channels of different sizes can be made formwork of precast elements, in situ concrete or with sliding formwork.

The channel covers must have a suitable bearing capacity according to the loads and traffic in the areas with a secure and quick locking system for easy (re)pulling of cables.

Gratings with a secure and quick locking system are suitable for easy (re)pulling of cables. Precast channel units type U are suitable for cable routing in paved areas. Using elbow-fittings, the channels can build any network.