



Oyu Tolgoi LLC

Health, Safety and Environment Management System Procedures

Element 10. Road construction and Maintenance Procedure
(C3 Vehicles and Driving Safety Standard)

Road Construction and Maintenance Procedure		
Effective Date: 2012.04.16	Document Number: OT-10-C3-PRC-0001-E	Version: 1.1

1 PURPOSE

The objective of this procedure is to provide sufficient details of design, construction, and maintenance practices to give operations the basic information required to optimise road running surfaces in the remote Gobi desert region of Oyu Tolgoi.

Road design, construction and maintenance has been identified as a high risk activity within Oyu Tolgoi LLC and the Rio Tinto Group.

2 SCOPE

This procedure applies to all employees and contractors of Oyu Tolgoi. It includes all roads owned and operated by Oyu Tolgoi or contractors that are employed onsite or offsite for Oyu Tolgoi LLC business purposes.

3 ROLES AND RESPONSIBILITIES

Role	Responsibilities
Employees, Contractors and Visitors	<ul style="list-style-type: none"> • Vehicles shall be driven within the prescribed speed limit and with due care and attention to the conditions. • Vehicles shall not be operated by individuals whilst under the influence of alcohol or other drugs in accordance with the Oyu Tolgoi Alcohol and Other Drugs Policy. • Conducting a vehicle pre start and safety check. • Reporting any faults or damage to the vehicle as soon as possible; • Reporting immediately and tagged 'OUT OF SERVICE' any failure or concern which affects the safe operation of the vehicle, i.e. brakes or steering. • Maintaining vehicles in a clean and tidy condition.
Supervisors	<ul style="list-style-type: none"> • Leased, owned or hired vehicles are maintained in accordance with the manufacturer's recommendations, and with the instructions of the leasing or renting organisation.
Superintendents	<ul style="list-style-type: none"> • Equipment involved in continuous operation shall be checked on a shift by shift basis in accordance with predetermined safety inspection standards. • Equipment that is used infrequently shall be checked prior to use.
Leader Once Removed (LOR) / Manager	<ul style="list-style-type: none"> • All vehicles used for work purposes shall be subject to a risk assessment as per the requirements of the <i>Safety Performance Standard C3 Vehicles and Driving</i>. The risk assessment should be stored in the vehicle. • All persons required driving heavy vehicles and light vehicle for work purposes in operational areas shall complete the <i>Annual Drivers Checklist</i> on an annual basis to reinforce safe driving techniques. • Vehicles shall not be used for towing unless they are engineered for that task. • Vehicle incidents and accidents occurring on public roads shall be reported to the local authorities in accordance with the requirements of the local laws. Accidents and infringements of

Road Construction and Maintenance Procedure		
Effective Date: 2012.04.16	Document Number: OT-10-C3-PRC-0001-E	Version: 1.1

	road regulations involving company vehicles shall be reported and investigated.
Department General Managers	<ul style="list-style-type: none"> A comprehensive risk analysis identifying the conditional and behavioural factors that impact vehicles and driving safety shall be conducted for each site in accordance with the requirements of <i>Rio Tinto Safety Performance Standard C3 Vehicles and Driving</i>. An action plan to address the findings shall be in place at each site and tracked to completion. The site C3 Committee shall ensure that speed limits, road signage and traffic rules are regularly reviewed and reinforced.

4 PROCEDURE

4.1 Design Phase

4.1.1 Mine Climatic Categorisation

It is helpful to categorise mines according to the climatic criteria, which affect the issues faced in developing haul roads, for example: Dry, Wet, Cold

It should be noted that at different times of the year, one mine could fit two (or all three) of the above climatic conditions. Each climatic category has its own issues, the more significant of which are discussed below.

4.1.1.1 Dry Mines

Dust is a major safety issue in dry mines. Repairable dust has the potential to lead to major occupational health problems. Both repairable and non-repairable dust can also create visibility problems, with the consequent risk of vehicle collisions. Loss of binding material as dust (or inadequate provision of binding material) can lead to unravelling of the road surface, which can result in the generation of loose material, with consequent traction problems. Corrugations (wash boarding) are also a problem associated with dry mines.

4.1.1.2 Wet Mines

Mud and unstable pavements are major problems in wet mines. Mud reduces traction, increases rolling resistance and softens the wearing surface by keeping it wet. It can block drains, often leading to pavement saturation and failure. Wearing course material cut off the road surface during maintenance activities cannot be reused if the road is covered in mud, so resurfacing requirements increase significantly in wet, muddy conditions.

Vehicle travel in wet, muddy conditions can result in significant suction forces as tyres lift off the wet pavements. These suction forces increase with vehicle speed and can lift sections of pavement and cause rapid pot holing, if the pavement is not tightly locked together.

Drainage is obviously a major issue in wet mines. Failure to provide adequate drainage will lead to water infiltration into the pavement, which will often lead to pavement failure. This is particularly important where the sub grade strength is low, or the lower pavement layers are constructed of relatively low strength material.

Road Construction and Maintenance ProcedureEffective Date:
2012.04.16Document Number:
OT-10-C3-PRC-0001-EVersion:
1.1**4.1.1.3 Cold Mines**

Ice causes loss of traction and pavement damage during thawing. Frost heave is a major issue as significant frost heave thawing leads to: Loosening and failure of the pavement and Wet mine issues during thawing.

Fresh snow causes loss of traction and blocking of drains and roads.

4.1.2 Pavement Design

The pavement comprises the part of the road above the sub-grade that provides the running surface.

The aim of pavement design is to select the most economic pavement thickness and composition, which will provide a satisfactory level of service for the anticipated traffic. In this context, economic means the overall result in terms of cost per tonne moved, after taking into account the cost of haul road construction, maintenance, and vehicle performance.

Refer to Rio Tinto Haul Road Design, Construction and Maintenance Guidelines (Reference A) Section 2.2 for detailed advice and guidance on pavement design.

4.1.3 Drainage

Road drainage channels, like natural streams, must convey both the water and sediment delivered to them. At particular stages of development, mine areas can generate significant sediment and management of this is often more difficult than the runoff water itself. Channel and culvert design has a major impact on sediment transport and deposition.

Refer to Reference A Section 2.3 for detailed advice and guidance on drainage.

4.1.4 Road Geometry

Roads should conform to good engineering practices within economic limitations and should have the following characteristics:

- Road gradients optimised with construction costs (including waste stripping) and vehicle cycle performance.
- Adequate sight distance for safety.
- Adequate passing widths.
- Super elevated curves.
- Effective cross fall drainage.

Refer to Reference A Section 2.4 for detailed advice and guidance on road geometry.

4.1.5 Intersections

Intersections are potentially the most hazardous part of the road system. A poorly designed intersection will invariably lead to traffic problems because of the conflicting traffic flow directions. These result in an area in which collisions are likely to occur.

4.1.5.1 Principles of Safe Intersections

A prime consideration in intersection design is safety. Safe intersection design is based upon the following principles:

- Reduction of the number of points of conflict;
- Minimisation of the area of conflict;
- Separation of points of conflict;
- Giving preference to major traffic movements;
- Control of speed;

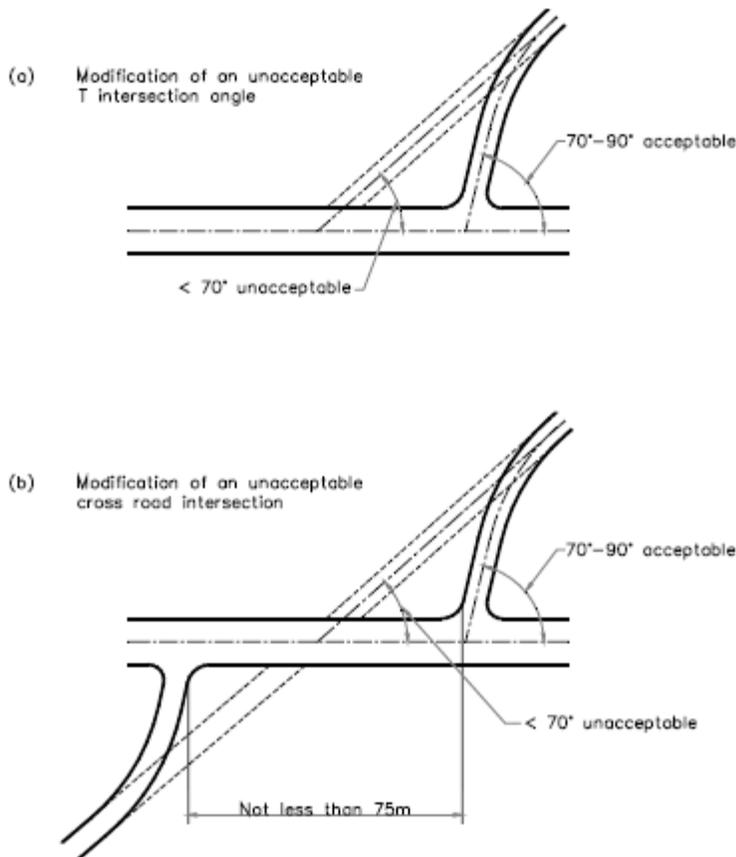
Road Construction and Maintenance Procedure		
Effective Date: 2012.04.16	Document Number: OT-10-C3-PRC-0001-E	Version: 1.1

- Definition of paths to be followed; and
- Clear, strategically placed signs and markings.

4.1.5.2 Intersection Type and Geometry

The .T. intersection is the simplest and one of the safer forms of intersection treatment, with the traffic on the through road having priority. The angle of the intersection should be 90 degrees, with the absolute minimum of 70 degrees, subject to satisfactory visibility for the particular traffic flow. Where the angle of the intersection is less than 70 degrees, the intersection should either be modified to provide the minimum angle (Figure 1), or configured so that vehicles with the adverse visibility are on the through road (right of way).

Figure 1 Example of Intersections



Creating Acceptable Intersection Angles

A cross intersection is undesirable in many situations unless treated to prevent high speed crossing movements. Designation of a major (priority) road is sometimes not effective to drivers unfamiliar with the area. An alternative to a straight cross intersection is a staggered .T. treatment, where one or both of the minor roads is staggered.

Road Construction and Maintenance Procedure

Effective Date:
2012.04.16

Document Number:
OT-10-C3-PRC-0001-E

Version:
1.1

At all intersections, the grade of the minor road should preferably be not more than 3% for a minimum approach distance of 30 metres, preferably 50 metres, to provide an approximately level area from which to stop and start, and to sight the traffic on the major road, whilst at the same time providing adequate drainage of water away from the intersection.

Refer to Reference a Section 2.5 for detailed advice and guidance on intersections.

4.1.6 Road Signs

In general, road rules should be basic and always applicable in any situation. Where this cannot be applied, road signs are mandatory, and must be obeyed by all traffic, and maintained on a regular basis.

Mongolian Road regulations will apply.

Refer to Reference A Section 2.6 for detailed advice and guidance on road signs.

Refer to HSE Standard Notices and Signs Procedure for further details

4.1.7 Guide Posts

Guideposts should be used to mark the edges of roadways, particularly to improve night time operations. They should be made of light durable material, for example timber or PVC tubing and should be painted white with red delineators fixed to face approaching traffic. White delineators should be fixed to the opposite side of the post.

Refer to Reference A Section 2.7 for detailed advice and guidance on guide posts.

4.2 Construction

Effective construction techniques are crucial to achieve a high performance road. This part of the procedure covers the main aspects that need to be addressed in any construction specification.

4.2.1 Soft Conditions

For soft sub-grade conditions, the following basic guidelines are recommended:

- Construct the road mainly as cuts rather than using the more traditional balanced cut and fill approach.
- Discard excavated soil and marginal materials.
- Minimise the amount of work given to the sub-grade. In cases where the subgrade compaction is inadequate, the sub-base layer should be thickened.

Refer to Reference a Section 3.1 for detailed advice and guidance on soft conditions.

4.2.2 Drainage

Temporary drainage ditches should be constructed along the road alignment immediately following clearing in order that surface water flows can be collected and directed away from the road works. Good drainage of the road should be maintained at all stages of road construction and throughout the operational life of the road.

If water is permitted to lie on the road surface, the traffic will cause the softened material in the puddle to be moved, causing a deeper and larger puddle and an increasing problem with pothole development.

Refer to Reference A Section 3.2 for detailed advice and guidance on drainage.

4.2.3 Preparation

Refer to Reference A Section 3.3 for detailed advice and guidance on preparation.

Road Construction and Maintenance Procedure

Effective Date:
2012.04.16

Document Number:
OT-10-C3-PRC-0001-E

Version:
1.1

4.2.4 Cut and Fill

Whenever cutting is required operators must exercise extreme care so as not to disturb the final shape of the batters or sub-grade surface. By starting the cut at the limit of the earthworks, close to the undisturbed vegetation, and progressively stepping the cut down until the desired level is attained, the final shape of the batters and the sub-grade can be most effectively controlled and efficiently completed.

Fill for earthworks are often obtained from the cutting as part of the road earthworks. Material should be placed in thick (0.5-1.5m) layers in the lower areas of the fills and not just dumped as if at a tip head. All the layers need to be compacted so as to limit the amount of subsidence that may occur.

Refer to Reference a Section 3.4 for detailed advice and guidance on cut and fill.

4.2.5 Compaction

Compaction gives strength to a material and therefore the compaction of the pavement layers is one of the most important factors affecting the durability of the pavement. A higher standard of compaction is required in the pavement than in embankments.

Designed compaction can be specified by an end result specification, or a method specification that is designed to achieve the required end result. The latter is more practical as the former requires a significant testing regime.

Refer to Reference a Section 3.5 for detailed advice and guidance on compaction.

4.2.6 Culvert Installation

Refer to Reference a Section 3.6 for detailed advice and guidance on culvert installation.

4.3 Maintenance

4.3.1 Causes of Road Deterioration

Regardless of how meticulously a haul road is planned and constructed, its surface will deflect under haul truck loading and such deflections have small cumulative components, which lead to damage to the pavement. Physical degradation of the pavement materials also occurs due to abrasion and environmental factors such rainfall and freezing.

One or a combination of the following causes deterioration of the road surface in varying degrees:

- Failure of the pavement due to inadequate design.
- Dry weather resulting in loss of fines (as dust) and hence unravelling of the surface texture.
- Heavy rain washing away the fines and hence unravelling the surface texture.
- Heavy rain saturating the surface material and turning the material into a mud layer.
- Heavy rain flooding of the pavement and causing soft spots and sub-grade failure.
- Over-watering by water trucks causing surface erosion and ponding.
- Spillage of product or overburden material.
- Wheel Rutting.
- Corrugations.
- Pot Holes.
- Damage due to frost heave, with a consequent reduction in pavement density upon thawing.
- Damage by tracked equipment.

Road Construction and Maintenance Procedure

Effective Date:
2012.04.16

Document Number:
OT-10-C3-PRC-0001-E

Version:
1.1

Refer to Reference A Section 4.1 for detailed advice and guidance on road deterioration.

4.3.2 Road Surface Maintenance

Refer to Reference a Section 4.2 for detailed advice and guidance on road surface maintenance.

4.3.3 Median Berms

All areas where loose material is employed to increase rolling resistance for vehicle retardation (escape lanes, median berms) should be periodically checked for loose consistency. If these areas become compacted, a bulldozer equipped with scarifying equipment should be used to break the surface.

Refer to Reference a Section 4.3 for detailed advice and guidance on median berms.

4.3.4 Road Signs and Guideposts

Cleaning should be carried out on a monthly basis. Damaged or substandard missing signs/guideposts should be repaired or replaced immediately.

Refer to Reference a Section 4.4 for detailed advice and guidance on road signs and guideposts

4.3.5 Drainage Maintenance

The drainage system operates in three dependent stages:

- Removal of water from the road surface to the V drains by having adequate cross falls for the rain conditions.
- Removal of water from the V drains to the local drain system by having adequate V drain gradients.
- Removal of the water from the local drain system to the regional drain system by having an adequate regional drainage design.

If any of these three stages does not operate correctly, the total drainage system breaks down.

Refer to Reference A Section 4.5 for detailed advice and guidance on drainage maintenance.

5 DEFINITIONS

Vehicle: Any motorised wheeled conveyance used for work purposes including light vehicles and mobile equipment; but excluding locomotives and machines operated on a rail system.

Shall: Indicates that a requirement is mandatory

Should: Indicates that a requirement is recommended

Road Construction and Maintenance Procedure		
Effective Date: 2012.04.16	Document Number: OT-10-C3-PRC-0001-E	Version: 1.1

6 REFERENCES AND RELATED DOCUMENTS

	Name	Location
Legal and Other Requirements	Rio Tinto HSEQ Element 10 Operational Control	Prospect
Oyu Tolgoi HSE Management System	Rio Tinto Haul Road Design, Construction and Maintenance Guidelines – February 2004 (Rio Tinto Technical Services) [reference A]	OT HSE Portal
	Element 10 – Operational Control	
	OT-10-PRC-0005-E-HSE Standard Notices and Signs Procedure	
	OT-10-C3-PRC-0005-E-Traffic Management Plan	
	OT-10-C3-PRC-0004-E-Tyre and Rims Management Plan	
	OT-10-C3-PRC-0006-E- Licencing Procedure	
	OT-10-C3-PRC-0002-E- Light Vehicle Procedure	
	OT-10-C3-PRC-0003-E- Heavy Vehicle Procedure	
	OT-10-C3-PRC-0001-E- Road Construction and Maintenance Procedure	



Road Construction and Maintenance Procedure		
Effective Date: 2012.04.16	Document Number: OT-10-C3-PRC-0001-E	Version: 1.1

7 DOCUMENT CONTROL

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