Forth Road Bridge
Failure Mode and Effect Analysis (FMEA) - Saturday 17/01/09

DRAFT

																Resulting Assessment					
Line	Component No	Component and Function	Potential Failure Mode	Potential Effect of Failure	Economic Severity	Perception Severity	Overall Severity	Potential Causes of Failure	Occurrence	Current Controls, Prevention	Current Controls, Detection	Detection	RPN	Recommended Action	Responsibility and Target Completion Date	Action Taken	Economic Severity	Perception Severity	Overall Severity	Occurrence	Detection	RPN
1	1	Shuttle Plate horizontal thrust block-attached to plate.	Loss of horizontal restraint of plate train.	Plate train becomes free and could fall into joint.	5	10	10	Weld failure from fatigue.	4	None.	6 monthly inspections.	8	320									
2	1	"	"	"	5	10	10	Overloading of thrust block on shuttle plate (where wear between the feet and the track beams cause extra resistance).	5	None.	6 monthly inspections.	9	450									
3	1	"	"	"	5	10	10	General corrosion.	2	None.	6 monthly inspections.	7	140									
4	17	Shuttle Plate horizontal thrust block-attached to support.	Loss of horizontal restraint of plate train.	Plate train becomes free and could fall into joint.	5	10	10	Weld failure from fatigue.	4	None.	6 monthly inspections.	8	320									
5	17	"	"	"	5	10	10	Overloading of thrust block attached to support (where wear between the feet and the track beams cause extra resistance).	5	None.	6 monthly inspections.	7	350									
6	17	"	"	"	5	10	10	General corrosion.	2	None.	6 monthly inspections.	5	100									
7	18	"	"	"	5	10	10	Overloading of thrust block support (where wear between the feet and the track beams cause extra resistance). Local failure of the top flange/cracking around block within supporting steelwork.	1	None.	6 monthly inspections.	7	70									
8	2	Vertical bearing to Shuttle Plates-attached to plates.	Loss of vertical restraint of plate train.	Shuttle plate can rotate upwards about opposite bearing and protrude into carriageway.	5	7	7	Weld failure from fatigue.	6	None.	6 monthly inspections.	7	294									
9	2	"	"	"	5	7	7	Overloading of bearing block.	5	None.	6 monthly inspections.	6	210									
10	2	"	"	"	5	7	7	General corrosion.	2	None.	6 monthly inspections.	5	70									
11	19	Vertical bearing to Shuttle Plates-attached to supports.	Loss of vertical restraint of plate train.	Shuttle plate can rotate upwards about opposite bearing and protrude into carriageway.	5	4	4.5	Weld failure from fatigue.	6	None.	6 monthly inspections.	7	189									
12	19	"	"	"	5	4	4.5	Overloading of bearing block support beam top flange causing local failure of the top flange/cracking around block within supporting steelwork.	6	None.	6 monthly inspections.	7	189									
13	19	"	Wear of bearing block.	Poor vertical carriageway profile/step in carriageway.	2	2	2	Wear due to cyclic movement.	9	None.	6 monthly inspections.	2	36									
14	3	Shuttle Plate Holding Down Pin.	Loss of vertical restraint to plate train.	Plate train becomes free and can be dislodged, and could fall into joint.	5	10	10	Overloading of pin (where wear between the feet and the slide track beams cause increased dynamic movement).	4	None.	6 monthly inspections.	7	280									
15	3	"	"	"	5	10	10	General corrosion.	2	None.	6 monthly inspections.	2	40									

Forth Road Bridge
Failure Mode and Effect Analysis (FMEA) - Saturday 17/01/09

DRAFT

																	Resulting Assessment					
Line	Component No	Component and Function	Potential Failure Mode	Potential Effect of Failure	Economic Severity	Perception Severity	Overall Severity	Potential Causes of Failure	Occurrence	Current Controls, Prevention	Current Controls, Detection	Detection	RPN	Recommended Action	Responsibility and Target Completion Date	Action Taken	Economic Severity	Perception Severity	Overall Severity	Occurrence	Detection	RPN
16	4	Spring around Holding Down Pin to shuttle plate.	Loss of vertical restraint of plate train.	Plate train becomes free and can be dislodged.	5	10	10	Overloading of spring(where wear between the feet and the track beams cause increased dynamic movement).	5	None.	6 monthly inspections.	6	300									
17	4	"	"	"	5	10	10	General corrosion.	2	None.	6 monthly inspections.	2	40									
18	20	Tongue Plate Holding Down Pins.	Loss of vertical restraint to plate train.	Tongue plate becomes free and can be dislodged, and could fall into joint.	5	9	9	Overloading of pin (where wear between the feet and the slide track beams cause increased dynamic movement).	4	None.	6 monthly inspections.	7	252									
19	20	"	"	"	5	9	9	General corrosion.	2	None.	6 monthly inspections.	2	36									
20	21	Spring around holding down pin to tongue plate.	Loss of vertical restraint to tongue plate.	Plate becomes free and can be dislodged.	5	9	9	Overloading of spring(where wear between the feet and the track beams cause increased dynamic movement).	6	None.	6 monthly inspections.	6	324									
21	21	"	"	"	5	9	9	General corrosion	2	None.	6 monthly inspections.	2	36									
22	5	Shuttle plate / plate train.	Uneven vertical profile of running surface.	Potential for "cat1" surface profile defect due to poor vertical profile.	1	2	1.5	Wear of joint components.	10	None.	6 monthly inspections.	2	30									
23	5	"	Loss of textured running surface.	Lack of skid resistance for vehicles.	2	6	4	Tyre wear to joint surface.	9	None.	Daily	2	72									
24	5	"	Failure of plates.	Plate train becomes free and could fall into joint.	5	10	10	Impact loading increased due to lack of fit.	2	None.	6 monthly inspections.	8	160									
25	5	"	"	"	5	10	10	Excessive corrosion.	1	None.	6 monthly inspections.	2	20									
26	6	Tongue Plate.	Excessive wear of plate thickness.	Plate ends further back giving poor vertical alignment.	1	2	1.5	Increased vehicle impact effects.	10	None.	6 monthly inspections.	2	30									
27	6	"	Loss of textured running surface.	Lack of skid resistance for vehicles.	2	6	4	Tyre wear to joint surface.	9	None.	Daily	2	72									
28	6	"	Failure of plates.	Tongue plate would fall into joint.	5	10	10	Tyre wear to joint surface.	2	None.	6 monthly inspections.	8	160									
29	6	"	"	"	5	10	10	Corrosion.	1	None.	6 monthly inspections.	2	20									
30	7	Feet supporting plate train.	Failure of connection between feet and plates.	Collapse of plate train or plate train falls into joint.	5	10	10	Weld failure from fatigue.	6	None.	6 monthly inspections.	8	480									
31	7	"	"	"	5	10	10	Impact loading due to lack of fit.	6	None.	6 monthly inspections.	8	480									
32	10	Hinge between plates in plate train.	Failure of hinge pins.	Plate train becomes free and could fall into joint.	5	10	10	Fatigue failure of pin.	5	None.	6 monthly inspections.	9	450									
33	10	"	"	"	5	10	10	Impact loading due to lack of fit.	7	None.	6 monthly inspections.	10	700									
34	10	"	"	"	5	10	10	Excessive wear in pin.	4	None.	6 monthly inspections.	9	360									

Forth Road Bridge
Failure Mode and Effect Analysis (FMEA) - Saturday 17/01/09

DRAFT

																	Resulting Assessment					
Line	Component No	Component and Function	Potential Failure Mode	Potential Effect of Failure	Economic Severity	Perception Severity	Overall Severity	Potential Causes of Failure	Occurrence	Current Controls, Prevention	Current Controls, Detection	Detection	RPN	Recommended Action	Responsibility and Target Completion Date	Action Taken	Economic Severity	Perception Severity	Overall Severity	Occurrence	Detection	RPN
35	10	"	"	"	5	10	10	Overloading of pin (where wear between the feet and the track beams cause extra resistance).	5	None.	6 monthly inspections.	10	500									
36	9	End keeper plate to hinge pins.	Plate becomes unattached.	Hinge pin 'works out' from bushing causing plates to come apart.	5	10	10	Weld failure from fatigue.	2	None.	6 monthly inspections.	4	80									
37	8	Hinge pin bush.	Bearing areas crack and fail.	Hinge separates and overloads other components. Plate train could become free and fall into joint.	5	10	10	Impact loading due to lack of fit.	10	None.	6 monthly inspectio	1	100									
38	8	"	Bearing areas wears excessively.	Plate train seizes due to excessive plan rotation and overloads other components. Plate train could become free and fall into joint.	5	10	10	Excessive wear in bushing.	10	None.	6 monthly inspectio	1	100									
39	11	Foot to underside of end plate of plate train.	Loss of connection between foot and plate.	End plate drops onto track beam and support is lost to tongue plate.	5	5	5	Weld failure from fatigue.	3	None.	6 monthly inspectio	5	75									
40	12	Pedestal between moving parts of joint.	Loss of surfacing material.	"Cat1" defect. Poor vertical alignment causing damage to joint and / or vehicles.	2	2	2	Lack of bond of surfacing material to steel pedestal.	9	None.	Daily	2	36									
41	13	Horizontal/vertical restraint blocks to tongue plates-attached to support.	Restraint becomes detached from support beams.	Loss of horizontal/vertical restraint to tongue plates.	5	10	10	Weld failure from fatigue.	4	None.	6 monthly inspectio	8	320									
42	13	"	"	"	5	10	10	Overloading of horizontal restraint (where wear between the feet and the track beams cause extra resistance).	5	None.	6 monthly inspectio	7	350									
43	13	"	"	"	5	10	10	Impact loading due to lack of fit.	3	None.	6 monthly inspectio	8	240									
44	13	"	"	"	5	10	10	General corrosion.	2	None.	6 monthly inspectio	5	100									
45	23	Support to horizontal/vertical restraint blocks to tongue plates.	"	"	5	8	8	Overloading of supporting steelwork (where wear between the feet and the track beams cause extra resistance).	2	None.	6 monthly inspectio	7	112									
46	23	Support to horizontal/vertical restraint blocks to tongue plates.	"	"	5	8	8	General corrosion.	2	None.	6 monthly inspectio	7	112									
47	22	Horizontal/vertical restraint blocks to tongue plates-attached to tongue plate.	Restraint becomes detached from tongue plate.	Loss of horizontal/vertical restraint to tongue plates.	5	7	7	Weld failure from fatigue.	4	None.	6 monthly inspectio	7	196									
48	22	"	"	"	5	7	7	Overloading of horizontal or vertical restraint (where wear between the feet and the track beams cause extra resistance).	5	None.	6 monthly inspectio	5	175									
49	22	"	"	"	5	7	7	Impact loading due to lack of fit.	4	None.	6 monthly inspectio	5	140									
50	14	Backing plate at rear edge of tongue plate.	Loss of horizontal restraint of plate train.	Tongue plate becomes free and could fall into joint.	5	3	4	Weld failure from fatigue.	4	None.	None	10	160									
51	14	"	Wear of top edge of plate.	Damage to vehicle tyres.	2	4	3	Excessive wear.	9	None.	Daily	2	54									
52	15	Track Beams.	Excessive wear in top surface of top flange.	Increased resistance to movement of joint causing potential overload to other components (e.g. hinge pins and restraints).	8	2	8	Excessive wear.	6	None.	6 monthly inspectio	4	192									
53	15	"	Failure of top flange by rotation.	Loss of support to plate train causing excessive wear in plate train.	8	2	8	Excessive wear.	3	None.	6 monthly inspectio	4	96									
54	15	"	Failure of top flange by deflection	Loss of support to plate train causing excessive wear in plate train	8	4	8	Excessive wear.	3	None.	6 monthly inspectio	4	96									
55	15	"	"	"	8	4	8	Impact loading due to lack of fit.	1	None.	6 monthly inspectio	4	32									
56	16	Slide track flange splice plate.	Failure of splice plate connection.	Loss of support to plate train causing excessive deflection and wear in plate train.	3	2	2.5	Fatigue failure of bolt due to increased impact loading as a result of lack of fit. Wear of counter sunk bolt head.	3	None.	6 monthly inspectio	4	30									

Forth Road Bridge
Failure Mode and Effect Analysis (FMEA) - Saturday 17/01/09

DRAFT

																	Resulting Assessment					
Line	Component No	Component and Function	Potential Failure Mode	Potential Effect of Failure	Economic Severity	Perception Severity	Overall Severity	Potential Causes of Failure	Occurrence	Current Controls, Prevention	Current Controls, Detection	Detection	RPN	Recommended Action	Responsibility and Target Completion Date	Action Taken	Economic Severity	Perception Severity	Overall Severity	Occurrence	Detection	RPN
57																						
58																						
59																						
60																						