Recommendation:

Use of Alderox Release Agent to reduce winter carry back of the ATO

A Six Sigma Final Project Report By

Tim Gibson

As the Project Sponsor and Champion, I hereby acknowledge that this Six Sigma Project fulfills all requirements as agreed upon by the Process Owner, the Six Sigma Candidate, and me.	As the Process Owner, I hereby acknowledge that the necessary work, structure, and support exist for the successful hand-off of this project. I am confident that recommendation if implemented will support sustained results.	As the person responsible for identifying and tracking improvement projects, I hereby acknowledge the successful completion of this project, and I recognize my responsibilities for prioritizing & assigning future work associated with the opportunities identified in the final report.	As the Master Black Belt for this Project, I hereby declare that the tools, logic, structure, and progress associated with this project fulfill all KUCC Six Sigma requirements.
_____	_____	_____	_____
Date:	Date:	Date:	Date:

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Acknowledgements

I would like to acknowledge the following individuals for the help and support they provided in association with the success of this project.

Name	Role
Ron Doucet	Process Owner
Joshua Collins	Project Champion
Ron Rosegard	Supplier of Alderox – trial assistance
Gilles Allard	Delivery and support of trials
Vivien Hui	Supplier support
Pocket #4 Operators	Assistance during trials - all
Crusher Operators	Assistance during trials – all
Ross O'Keefe	Industrial Hygienist – Pinchin Environmental
Terrielynn Foster	Industrial Hygienist - IOC

Project Language

Listed below are the jargon, key terms, and acronyms used in this report. This section has been added to assist with the interpretation of the document.

TERM	DEFINITION / EXPLANATION
Alderox	Soya bean oil release agent – patented product sold by Company RACI
Automated SRS	Short form for: Automated Ore Car Spray Release System
Pocket #4	Ore Loading location at IOC
Carry back	Ore that fails to discharge at the crusher and is carried back to the pockets – this reduces net payload and contributes to unsafe operating conditions on the ATO
ATO	Automatic Train Operation
Winter months	Defined as the months of October to April of any year
Ore Cars Knocked	Using rock breaker at crusher to remove carry back to near zero

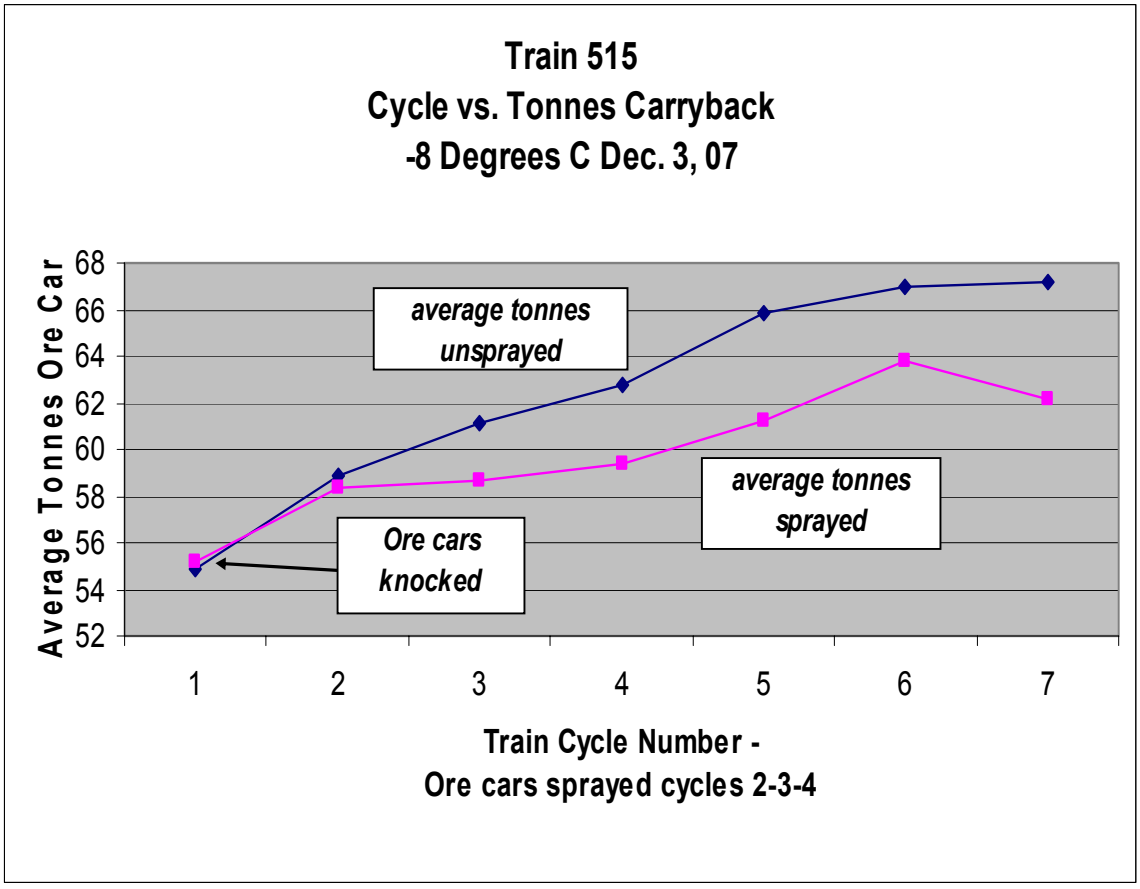
EXECUTIVE SUMMARY

This project focused upon the recommendation to use, or not to use the Ore Car Release agent Alderox to reduce carry back on ATO train system during winter months.

Work efforts associated with this project revealed a reduction in carry back of 33% and 83% respectively. Major trial actions that contributed to this improvement include: heating of the Alderox to 55 degrees C and spraying onto Ore Cars in Pocket 4 during "peak" carry back operating days – these were observed on December 3rd, and January 16th when outside temperatures were -8 C and -25 C respectively. Data was then collected both visually with pictures and retrieved from the crusher scales on an ore car, by car basis.

As a result of these improvements the reduction in carry back can be seen for both days in the following Figures 1 and 2 with attached data below:

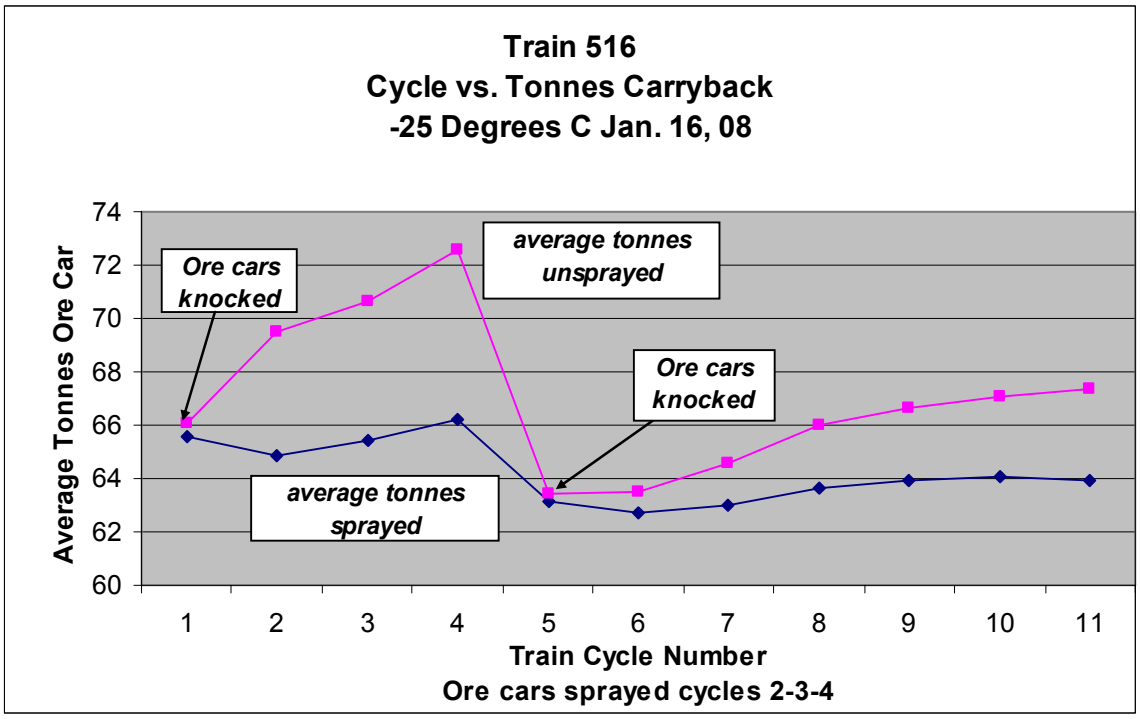
Figure 1



Data Figure 1

		knocked cycle 1	spray 1 cycle 2	spray 2 cycle 3	spray 3 cycle 4	no spray cycle 5	no spray cycle 6	no spray cycle 7
	Car Position	Exit Weight	Exit Weight	Exit Weight	Exit Weight	Exit Weight	Exit Weight	Exit Weight
	10	54.45	56.99	58.81	60.3	62.78	63.55	63.86
	11	54.29	59.51	64.59	67.9	70.6	72.14	71.28
	12	55.31	57.97	60.39	62	64.72	65.27	64.61
	13	54.13	59.83	62.73	64.32	67.99	69.26	70.26
	14	54.95	59.1	60.46	62.07	65.23	67.04	67.15
	15	55.61	59.21	60.98	61.96	62.93	70.55	65.13
	16	56.4	60.55	62.03	61.87	66.74	67.85	68.53
	17	54.88	59.42	57.15	57.44	59.26	59.03	59.19
	18	54.72	58.13	58.87	60.94	62.57	64	64.41
	19	55.2	56.4	57.88	58.6	61.44	61.82	62.14
Ave. sprayed		55.23	58.34	58.67	59.33	61.21	63.80	62.15
Ave. unsprayed		54.89	58.87	61.13	62.77	65.80	67.02	67.16

Figure 2



Data Figure 2

	knocked cycle 1	spray 1 cycle 2	spray 2 cycle 3	spray 3 cycle 4	no spray cycle 5	no spray cycle 6	no spray cycle 7	no spray cycle 8	no spray cycle 9	no spray cycle 10	no spray cycle 11
Car Position	Exit Weight	Exit Weight	Exit Weight	Exit Weight	Exit Weight	Exit Weight	Exit Weight	Exit Weight	Exit Weight	Exit Weight	Exit Weight
9	66.47	71.56	72.9	74.45	67.7	67	67.85	67.65		68.65	68.2
10	64.07	64.65	65.8	66.95	61.8	61.75	62.35	62.6		63.1	62.65
11	70.8	64.55	65.6	66.85	60.35	59.7	60.15	59.85	60.45	60.8	62.45
12	67.11	64.1	64.55	65.35	62.65	61.35	62.1	63.04	63.05	63.15	62.9
13	61.46	68.5	69.85	71.8	62.1	63	65.25	69.05	70.05	70.45	71.1
14	66.7	63.8	64.05	64.75	62.95	62.3	62.52	63	63.65	63.75	63.5
15	59.62	69.55	69.85	72.8	59.7	60.75	61.35	62.6	64.35	63.85	63.25
16	63.84	64.05	64.95	65	61.7	62.15	61.65	62.6	61.85	62.95	63.15
17	72.1	73.3	75.15	76.95	67.4	67.15	68.1	70.8	71.6	71.75	71.9
18	66.04	67.7	67.8	68.89	66.45	65.9	66.35	66.95	67.3	67.3	67.6
ave sprayed	65.552	64.86	65.43	66.188	63.11	62.69	62.994	63.638	63.9625	64.05	63.96
ave unsprayed	66.09	69.492	70.67	72.57	63.45	63.52	64.54	65.99	66.6125	67.1	67.38

The following table 1 summarizes the benefits observed during the trials conducted. Important to note is the residual benefits i.e. a reduction in carry back that was observed during the trials after the spraying had stopped.

Table 1

Summary Benefits of Spraying Ore Cars
(**only during spraying not residual**)

Trial Date	Temperature	Total Ore cars Sprayed	% Reduction Carry back
Dec. 3, 2007	-8	9	33%
Jan. 16, 2008	-25	15	83%

No Sustainability Assessment was performed, at the start of this trial as the intent of this project was a recommendation only. Change Management for this trial was completed for the trial use of Alderox and location of spraying only.

By implementing this recommendation the Ore Car Spray Release system the following are the ***anticipated benefits***:

The annual actual cost - benefit anticipated will be the following:

Cost

The target spray volume per ore car is .6 gallons at a cost of 5 dollars. Worst case scenario of spraying every ore car every pass would have IOC spend 100 dollars per train (20 cars). Total

cost per day would be 70 trains per day X 100 = $ 7,000. The total cost per year worst case scenario would then be 7K X 212 days = **1,484Kpa**

(Note: during trials a significant reduction in carry back was observed after spraying stopped, this is not factored here.)

Benefits

The incremental tonnes are estimated to be the following:

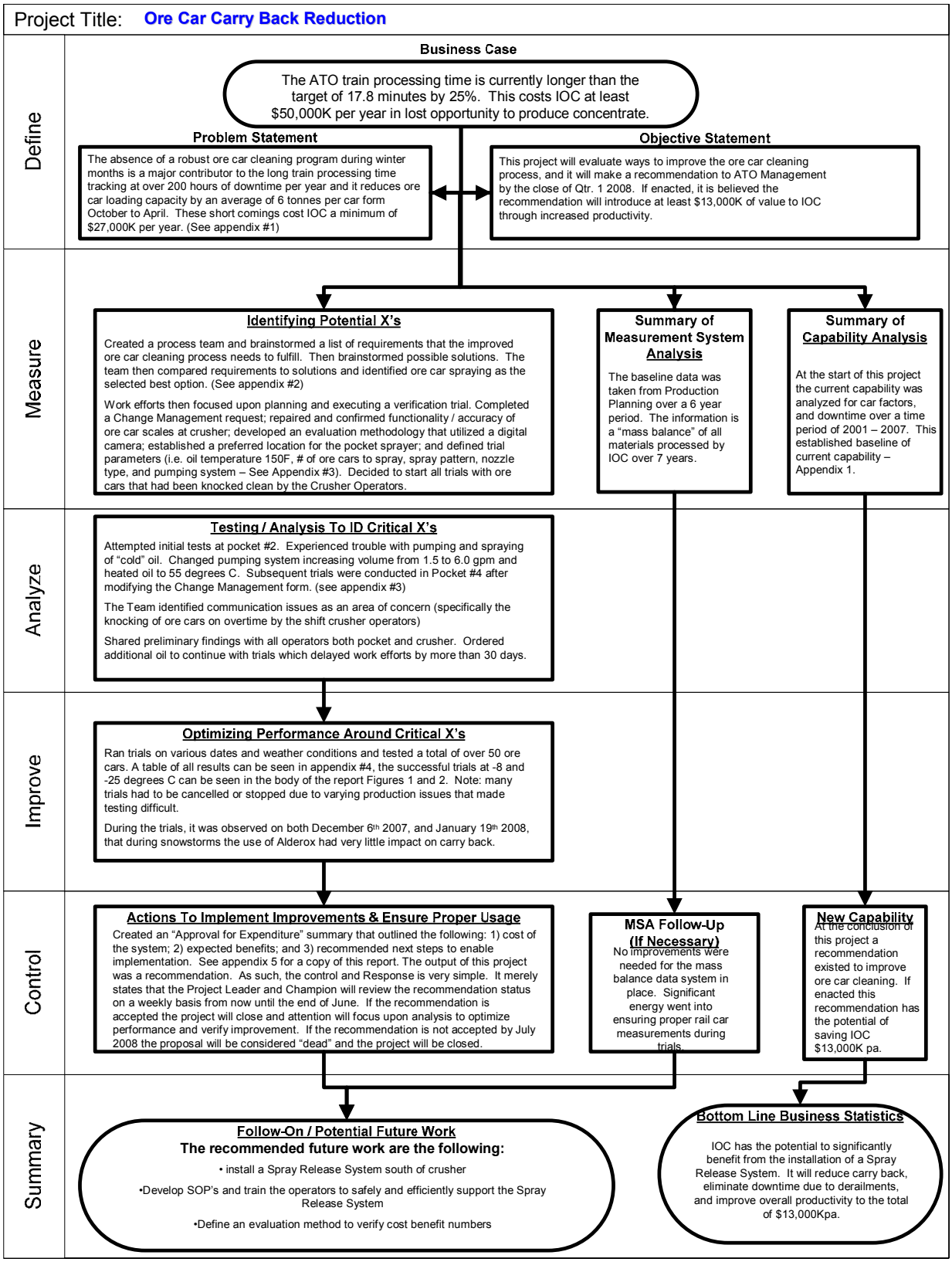
33% improvement in ore car factors from October to April annually. This is consistent with the lowest trial result completed at IOC and is the most conservative estimate.

Tonnes = 1.2 million (from Appendix #1 Ore Car Factor) X .33 = 400KTpa **of ore**
400KTpa X .4 weight yield X $40 dollars margin = $**6,400,000 pa**

The tonnes estimate includes worst case spraying scenarios' and does not include any reduction in train processing time i.e. winter knocking to clean out ore cars or any reduction in derailments which occur annually due to imbalanced ore car loads caused by excessive winter carry back.

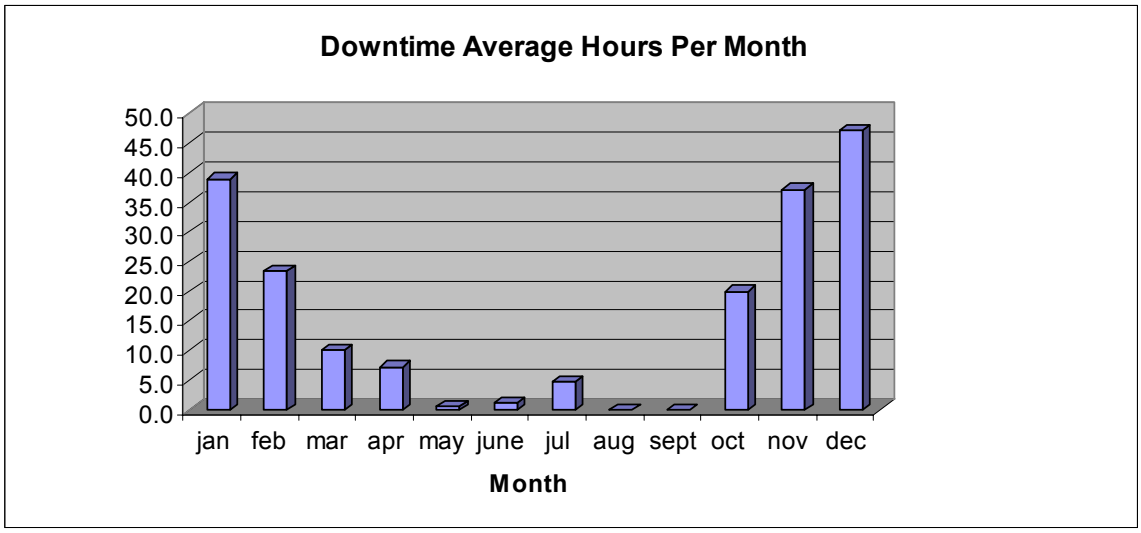
This **recommendation to proceed with a Permanent Structure** - Appendix #5 located just south of the crusher building will allow IOC to quickly use any spray release agent should a cheaper or more effective solution emerge in the months and years to come.

The project flow map below highlights the work efforts associated with this Business Improvement initiative and the 6 Sigma Process Flow.


Project Title: Ore Car Carry Back Reduction
Define
Business Case
The ATO train processing time is currently longer than the target of 17.8 minutes by 25%. This costs IOC at least $50,000K per year in lost opportunity to produce concentrate.
Problem Statement
The absence of a robust ore car cleaning program during winter months is a major contributor to the long train processing time tracking at over 200 hours of downtime per year and it reduces ore car loading capacity by an average of 6 tonnes per car form October to April. These short comings cost IOC a minimum of $27,000K per year. (See appendix #1)
Objective Statement
This project will evaluate ways to improve the ore car cleaning process, and it will make a recommendation to ATO Management by the close of Qtr. 1 2008. If enacted, it is believed the recommendation will introduce at least $13,000K of value to IOC through increased productivity.
Measure
Identifying Potential X's
Created a process team and brainstormed a list of requirements that the improved ore car cleaning process needs to fulfill. Then brainstormed possible solutions. The team then compared requirements to solutions and identified ore car spraying as the selected best option. (See appendix #2)
Work efforts then focused upon planning and executing a verification trial. Completed a Change Management request; repaired and confirmed functionality / accuracy of ore car scales at crusher; developed an evaluation methodology that utilized a digital camera; established a preferred location for the pocket sprayer; and defined trial parameters (i.e. oil temperature 150F, # of ore cars to spray, spray pattern, nozzle type, and pumping system – See Appendix #3). Decided to start all trials with ore cars that had been knocked clean by the Crusher Operators.
Summary of Measurement System Analysis
The baseline data was taken from Production Planning over a 6 year period. The information is a "mass balance" of all materials processed by IOC over 7 years.
Summary of Capability Analysis
At the start of this project the current capability was analyzed for car factors, and downtime over a time period of 2001 – 2007. This established baseline of current capability – Appendix 1.
Analyze
Testing / Analysis To ID Critical X's
Attempted initial tests at pocket #2. Experienced trouble with pumping and spraying of "cold" oil. Changed pumping system increasing volume from 1.5 to 6.0 gpm and heated oil to 55 degrees C. Subsequent trials were conducted in Pocket #4 after modifying the Change Management form. (see appendix #3)
The Team identified communication issues as an area of concern (specifically the knocking of ore cars on overtime by the shift crusher operators)
Shared preliminary findings with all operators both pocket and crusher. Ordered additional oil to continue with trials which delayed work efforts by more than 30 days.
Improve
Optimizing Performance Around Critical X's
Ran trials on various dates and weather conditions and tested a total of over 50 ore cars. A table of all results can be seen in appendix #4, the successful trials at -8 and -25 degrees C can be seen in the body of the report Figures 1 and 2. Note: many trials had to be cancelled or stopped due to varying production issues that made testing difficult.
During the trials, it was observed on both December 6th 2007, and January 19th 2008, that during snowstorms the use of Alderox had very little impact on carry back.
Control
Actions To Implement Improvements & Ensure Proper Usage
Created an "Approval for Expenditure" summary that outlined the following: 1) cost of the system; 2) expected benefits; and 3) recommended next steps to enable implementation. See appendix 5 for a copy of this report. The output of this project was a recommendation. As such, the control and Response is very simple. It merely states that the Project Leader and Champion will review the recommendation status on a weekly basis from now until the end of June. If the recommendation is accepted the project will close and attention will focus upon analysis to optimize performance and verify improvement. If the recommendation is not accepted by July 2008 the proposal will be considered "dead" and the project will be closed.
MSA Follow-Up (If Necessary)
No improvements were needed for the mass balance data system in place. Significant energy went into ensuring proper rail car measurements during trials.
New Capability
At the conclusion of this project a recommendation existed to improve ore car cleaning. If enacted this recommendation has the potential of saving IOC $13,000K pa.
Summary
Follow-On / Potential Future Work
The recommended future work are the following:
• install a Spray Release System south of crusher
•Develop SOP's and train the operators to safely and efficiently support the Spray Release System
•Define an evaluation method to verify cost benefit numbers
Bottom Line Business Statistics
IOC has the potential to significantly benefit from the installation of a Spray Release System. It will reduce carry back, eliminate downtime due to derailments, and improve overall productivity to the total of $13,000Kpa.

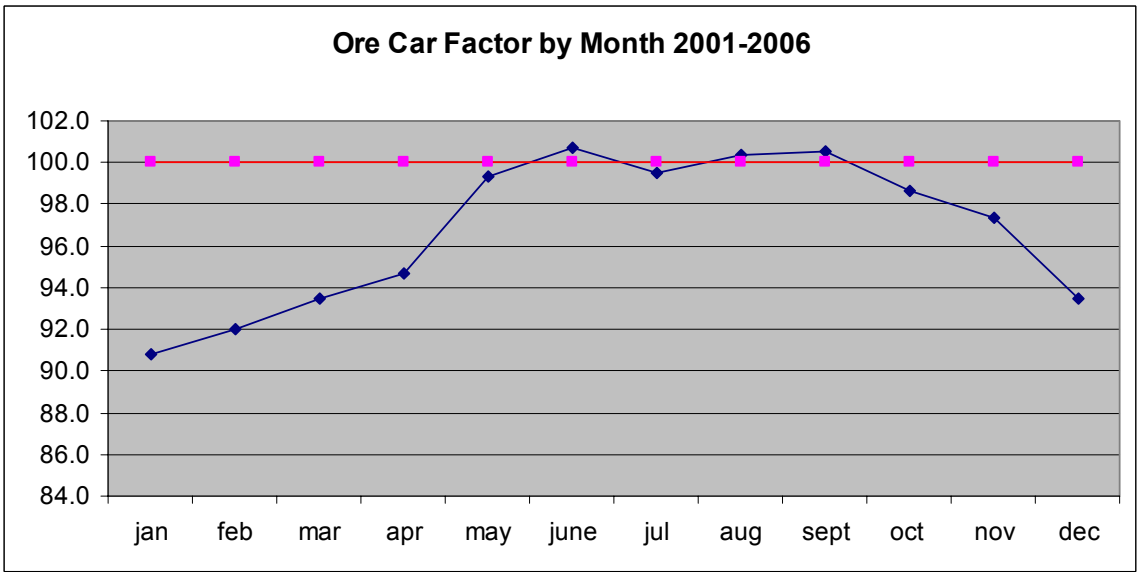
Appendix #1

Data summary 2003 – 2007 (Damian Power – Production Planning)



* Over 200 hours downtime = > 600,000 tonnes of ore lost

Data summary 2001 – 2006 (Damian Power – Production Planning)



* At 100 tonne ore car factors = > 1,100,000 tonnes of ore lost

Appendix #2

Requirements to reduce ore car cleaning	Duratray	Spray Release	Fish Oil
minimize carry back	+	+	+
eliminate carry back	+	+	+
ease of implementation	-	+	+
cost	-	+	-
environmental impact	+	+	-
operator involvement	+	+	+

Summary	4+/2-=+2	=6+	4+/2-=+2

Note: Spray release selected

Appendix #3 Improved Pumping and Spray System – 4 pumps @200 psi and 1.5 gpm. Oil heated to 150F.

45 Gallon Drum - without heater blanket

Appendix 4

Chart of all days sprayed and general results, provided by Pinchin Environmental.

Date	Location	Train	No. of Cars	Weather						
				Conditions	Temperture		Wind Direction	Wind Speed		Wind Chill	
					Deg C		Perdominate	Km/hr		C	
21-Nov-07	# 2 Pocket			Snow Showers	-6.8	-12.8	SW	0	13	0	-13
22-Nov-07				Snow/Ice Crystals	-11.6	-23.3	SW	0	9		
28-Nov-07	# 2 Pocket			Snow	-12.8	-18.6	NW	13	22	-20	-28
29-Nov-07	# 4 Pocket		20	Snow/Ice Crystals	-11.6	-21	S	0	19	-18	-30
03-Dec-07	# 4 Pocket	515	19	Snow	-5.8	-10.4	NE	9	22	-12	-17
05-Dec-07	# 4 Pocket			Snow/Ice Crystals	-14.6	-22.1	SW	0	15	0	-30
06-Dec-07	# 4 Pocket	515	19	Snow/Ice Crystals	-17.4	-20.3	SW	0	28	-26	-30
16-Jan-08	# 4 Pocket	516	18	Clear	-19.2	-30	Calm	0	13		
17-Jan-08	# 4 Pocket	519	19	Ice Crystals	-8.8	-31	SW	0	22	-15	-38
17-Jan-08	# 4 Pocket	516	18	Ice Crystals	-8.8	-31	SW	0	22	-15	-38
18-Jan-08	# 4 Pocket	519	20	Snow	-7	-10.9	S	7	32	-14	-18
18-Jan-08	# 4 Pocket	516	18	Snow	-7	-10.9	S	7	32	-14	-18
21-Jan-08	# 4 Pocket	513	20	Ice Crystals	-31.2	-35.7	W	6	30	-45	-50

Note:

Trials were discontinued on various days due to the following problems:

- Pumps freezing
- Temperature in #2 pocket
- Failure of spray gun
- Lack of trains
- Ore cars being switched onto train line
- Derailment
- Communication problems with crusher operator
- Production priorities

Appendix 5 – Recommendation to Proceed with Permanent Structure

January 31, 2008

Ore Car Carry back Reduction – Approval for Expenditure

Approval is sought for up to $125K out of budget operating funds to purchase and install an automated Ore Car Spray Release System (SRS) for a reduction in carry back. This expenditure is a one time cost for an automated system to be installed south of the crusher to allow for Alderox (soya bean release agent) to be sprayed into the ore cars and reduce the amount of carry back in winter months. The building cost will be offset by an increase in tonnes produced; the cost of the equipment spray system will be installed at no cost to IOC by RACI the Alderox supplier.

Business Context

During the winter months November-April the ATO experiences excessive carry back. This is caused by Ore being frozen to the Ore Car by temperatures which average -20 degrees Celsius. Pocket loading at IOC further exacerbates the problem as pockets 3 and 4 have warmer temperatures and increased condensation levels. Ore Car factors in winter months over the last 5 years average below 94 tonnes while in the summer months the average is 100 tonnes.

Two successful Alderox trials at IOC have demonstrated the following:

Trial Date	Temperature	% Reduction Carry back
Dec. 3, 2007	-8	33%
Jan. 16, 2008	-25	85%

In addition to the benefits of carry back reduction a significant “residual” benefit has been seen the next day when the trial ore cars have not been sprayed. This residual benefit will potentially reduce both the amount of oil and the frequency of spraying when the permanent system is installed. For this analysis a worst case scenario will be used in Cost and Benefits analysis.

Project Scope

A detailed installation schedule is now being developed. The intention is to have the building of 320 sq. ft. delivered in 2 sections and installed at IOC south of the crusher building in late February 2008. The ATO will provide the power drop to the structure. Change Management documentation will be completed prior to the start of any work.

The installation of the automated spray system will be the responsibility of RACI. Change Management documentation will be completed and all work supervised by IOC personnel. Tracking of any reduction in downtime, and carry back will be done by the Primary Ore Continuous Improvement Department to determine success of the implementation.

Costs & Benefits

The initial installation costs are estimated at $150k.

The actual benefit anticipated will be the following:

The target spray volume per ore car is .6 gallons at a cost of 5 dollars. Worst case scenario of spraying every ore car every pass would have IOC spend 100 dollars per train (20 cars). Expected benefit (using conservative 50% reduction) would be 3 tonnes X 20 cars or 60 tonnes per train processed or approximately 1000 dollars of incremental margin, or 70,000 dollars per day for 70 trains.

The proposal estimates a 10:1 cost benefit ratio, which includes worst case spraying scenarios' and does not include any reduction in train processing time i.e. winter knocking to clean out ore cars or any reduction in derailments which occur annually due to excessive winter carry back.

This proposal will allow IOC to quickly use any spray release agent should a cheaper or more effective solution emerge in the months and years to come.

Risks

1. The Alderox Spray release agent does not work consistently.

2. Too much Alderox is required to achieve the expected result in carry back reduction.

3. The installation of the SRS negatively impacts the current IOC production system.

    - All of the above risks will be mitigated through proper Project Management, and a thorough Risk Assessment prior to implementation date scheduled for late February 2008.
    - Thorough data analysis will be ongoing as a part of the 6 Sigma Project – this will allow for quick changes to spray rates and changing weather conditions.
    - Monthly updates will continue to be given to the ATO through their "Reduction in Train Processing" initiative
    - The system can be turned off at any time for any reason.
    - The installation does not impact current IOC production methods. "Tying" in of the SRS can be done during a scheduled crusher outage or any other unplanned event.