

TOXIC SUBSTANCE REDUCTION PLAN

FOR

**MINERAL SPIRITS**

VACUUM METALLIZING LIMITED  
30 DOVEDALE COURT  
TORONTO, ON M1S 5A7

### ***C. TOXIC SUBSTANCE REDUCTION PLAN FOR MINERAL SPIRITS***

Mineral spirits is one of five toxic substances used at the facility for which Toxic Substance Reduction Plans (TSRP's) are required. Mineral spirits is defined as a petroleum distillate mixture of C7 to C12 alkanes (paraffins) and cycloalkanes (naphthalenes) where the mixture is in the range from 5% to 20% aromatics by weight, is less than 0.1% benzene by weight, has a boiling point in the range of 130°C to 220°C and has a flash point in the range from 21°C to 60°C. Solvents/solvent blends included in this class used at Vacuum Metallizing Limited go by the names mineral spirits, odourless mineral spirits, VM&P naptha and 2024 naptha and include CAS numbers 8032-32-4, 8052-41-3, 64742-48-9, 64742-49-0, 64742-88-7 and 64742-89-8. This TSRP is concerned with usage of all of these substances, although only two were used in amounts equal to or greater than the 1 tonne reporting threshold.

All solvents are used at the facility in the same processes and in many situations are emitted together. To avoid unnecessary duplication, information common to all of the TSRP's is provided in a single Master Document and this Master Document is referenced by the TSRP for each toxic substance. Accordingly The Master Document and this TSRP for mineral spirits comprise Vacuum Metallizing Limited's complete Toxic Substance reduction Plan for mineral spirits.

#### ***1. Facility Identification***

See Master Document, Section 1.

#### ***2. Contacts***

See Master Document, Section 2.

#### ***3. Intention to Reduce Use of Mineral Spirits and Objective of This TSRP:***

See Master Document, Section 3.

#### ***4. Use of Mineral Spirits***

See Master Document, Section 4 for a description of how and where mineral spirits and other solvents are used at Vacuum Metallizing Limited.

In 2011, all of the mineral spirits used at the facility arrived in paints purchased from suppliers and/or was used as a thinner in paint formulations for the following paints: 33C36, 3003, AB235/VB226, 3001/AB35 (blend), SW7000, Multi-4U and PSCW-20L.

The following chart illustrates how these paints are used:

	<u>Spray Paint Application</u>		<u>Flowcoat Paint Application</u>	
	<u>Basecoat</u>	<u>Topcoat</u>	<u>Basecoat</u>	<u>Topcoat</u>
33C36	X		X	X
3003	X			
AB35/V226	X			
AB35			X	X
3001/AB35	X			
SW7000	X			
Multi-4U	X			
PSCW-20L	X (machine maintenance only)			

#### **4.1 Stages and Processes that Use Mineral Spirits**

See Master Document, Section 4.1 for a description of the stages and process at vacuum Metallizing Limited.

#### **5. Tracking of Mineral Spirits at the Process Level**

See Master Document, Section 5 for a description of each stage and process at Vacuum Metallizing Limited. A process flow diagram is provided for each process to provide a visual illustration of:

- how mineral spirits enters the process
- whether mineral spirits is created, destroyed or transformed during the process
- how mineral spirits leaves the process and what happens to it after it leaves the process

Notational references contained in this TSRP document (e.g. U, Int1, Int2, Dis1, A3) are the same as those used in the Master Document.

The processes in which each of the above-listed paints containing mineral spirits is used are as follows:

Receiving Stage – Solvent Receiving and Storage Process: All above-listed paints  
Basecoat Stage

Spray Painting Preparation, Spray Painting and Spray Paint Curing Processes: 33C36, AB35/VB226, 3001/AB35, 3003, SW7000, Multi-4U

Flowcoat Painting Preparation, Flowcoat Painting and Flowcoat Curing Processes: 33C36, AB35

Topcoat Stage

Spray Painting Preparation, Spray Painting and Spray Paint Curing Processes: 3003

Flowcoat Painting Preparation, Flowcoat Painting and Flowcoat Curing Processes: 33c36, AB35

## 6. *Tracking and Quantification of Mineral Spirits at the Process Level*

In this section, the following information is identified or presented for each of the processes identified in Section 5 in which mineral spirits is used:

- the method or combination of methods used to track and quantify mineral spirits in the process
- why the method or combination of methods was chosen
- the quantification of mineral spirits in the process
- an explanation of any discrepancy between the input quantity (use of mineral spirits) and the output quantity (release and disposal of mineral spirits)

All mineral spirits used at Vacuum Metallizing Limited is ultimately released to air or disposed of and none is transformed, destroyed or contained in products (i.e. in cured coatings applied onto customer-supplied components).

In this TSRP, individual releases and disposals of mineral spirits exiting processes are not quantified and separated from cumulative releases where (a) the amount of an individual release/disposal is not measured, and (b) the quantity of the individual release/disposal is not significant relative to the quantity released/disposed by the primary source of release (e.g. the mass of mineral spirits releases/disposals from maintenance activities as compared to the amount released/disposed from production activities). Measuring and quantifying these small releases would require source sampling and the associated expense cannot be financially justified considering the small amount of potential savings and the fact that any meaningful toxic substance/cost reduction strategy would not address these small individual address sources of release but would affect the use of all paints and solvents (and the toxic substances contained within them) in every process.

The information presented herein for each process, refers to the process description and corresponding process flow diagram presented in the Master Document.

### **SOLVENT RECEIVING AND STORAGE PROCESS**

As noted, all paints that are purchased are received and moved to the Paint Storage Room (input U). Drums to be dispensed are moved onto a rack and stored in horizontal position. The paint may be used as a sprayed basecoat (Int2), a sprayed topcoat (Int3), a flowcoated basecoat (Int4) or a flowcoated topcoat (Int5). Mineral spirits is never used as a rinse agent prior to basecoating in the flowcoater, (i.e. Pretreatment Process has mineral spirits usage Int1 = 0), however mineral spirits is used to rinse out spray guns and paint lines in the Spray Painting Department before paint changes and to clean spray equipment at the end of each. Mineral spirits may evaporate upon removing the bung in a drum and inserting a dispensing valve, from a dispensing valve that leaks because it does not thread in or close properly, and from a rag used to clean up the spilled solvent (A1). Mineral spirits may remain in the rag when it is thrown in the trash (Dis1).

Process input/output balance calculation:  $U = \text{Int1} + \text{Int2} + \text{Int3} + \text{Int4} + \text{Int5} + \text{A1} + \text{Dis1}$

#### **a) Mineral spirits that enters the process (U)**

(i) *Quantification Method : Mass Balance*

Supplier invoices provide the number of containers received and the net weight of each.

(ii) *Best Available Method Rationale:*

This information is accurate and the method is cost effective as it is obtained directly from accounting documents and information supplied from the manufacturers of the paints and no additional measurements are required. Containers are not opened or damaged during this sub- process and they do not leak so 100% of received material is moved to the Paint Storage Room.

(iii) *Data Quality:*

The quality of the data is considered “High” for reasons presented above.

(iv) *Calculations of total mass of mineral spirits that enters the process:*

The total mass of mineral spirits that enters the process is the sum of the amount received in drums for use as paint thinner plus the amount received in purchased paints. These amounts are calculated as follows:

Amount received for use as paint thinner = (# drums of mineral spirits received) x (kg of mineral spirits per drum)

Amount contained in purchased paint = (# containers of paint received ) X (litres of paint per container) X (litre of mineral spirits per litre of paint) X (kg of mineral spirits per litre of mineral spirits)

The total mass of mineral spirits used in the process was 7,750 kg in 2011. Of this amount, 4,143 kg was received in drums for use as paint thinner and 3,607 kg was received as a formula ingredient in purchased paints. Associated calculations are presented in Table F1.

**Mineral spirits exiting the process (Int1, Int2, Int3, Int4, Int5, D1, A1):**

(i) *Quantification Method : Combination of mass balance, engineering calculations and “best guess” estimate.*

As explained in the Master Document, amounts of mineral spirits released to air (A1) and disposed (D1) are considered to be negligible (i.e.  $A1 = D1 = 0$ ). Accordingly, the total amount of heptane exiting the process ( $Int1+Int2+Int3+Int4+Int5+A1+D1$ ) should be equal to the amount entering the process (U) less/plus any increase/decrease in the year-end inventory level versus the starting inventory level.

No records are made of the amount of paint and solvent material drawn from inventory for use in the individual processes at the facility.

Engineering calculations are used to determine the amount of mineral spirits contained in the paint mix used in each of the subsequent processes as follows:

Mineral spirits usage = (number of production loads painted) x (volume of paint mix per load) x (percentage of paint mix that is mineral spirits) x (density of mineral spirits).

The total amount of mineral spirits exiting the process and which enters a subsequent process is the sum of the calculated usages of mineral spirits for all paints used in that subsequent process.

The number of production loads, paint mix formulas and paint mix consumption per production load are obtained from operating and production records. The density of mineral spirits is obtained from supplier records.

*(ii) Best Available Method Rationale:*

This information is cost effective as it is obtained directly from the accounting documents, company supervisors, NPRI/ECA documentation and information supplied from the mineral spirits distributor and no additional measurements are required. In any event the method used is the only one available as the amounts of mineral spirits drawn from inventory for use in each of the subsequent processes are not recorded and physical measurement is not effective because painted items vary considerably in shape, size and quantity requiring constant modification of machine operating settings.

*(iii) Data Quality*

The quality of the data is considered “Average” as quantifications are derived from fundamental scientific principles, relevant empirical data and judgement based on extensive observation. Only a relatively small amount of mineral spirits exits the process for use in the Pretreatment Process so the low data quality for Int1 is not a significant consideration. (Although the data quality associated with the distribution of mineral spirits usage between the five subsequent processes may not be as high as one would like, the data quality for the sum of the individual usages is “High”. ) See *Data Quality* in Section 6 of the Master Document.

*(iv) Calculations of total mass of mineral spirits that exits the process:*

The amount of mineral spirits leaving the process is the sum of mineral spirits used in applied paints plus mineral spirits used to wash spray paint lines and spray guns.

No mineral spirits is used in the pretreatment process, hence Int1 = 0:

Calculations for amounts of mineral spirits exiting to the Spray Paint Basecoat Preparation Process (Int2), Spray Paint Topcoat Preparation Process (Int3), Flowcoating Basecoat Paint Preparation Process (Int4) and Flowcoat Paint Topcoat Preparation Process (Int5) from applied paints are presented in Table F2 and calculated as follows:

$Int_n = (\% \text{ mineral spirits in thinner}) \times (\% \text{ thinner in paint mix}) \times (\text{litres paint mix per production load}) \times (\text{density of mineral spirits})$

The amount of mineral spirits used to rinse spray guns and paint lines that exited the process is calculated as follows:

Usage = [(average #spray machines used X 1 rinse at the end of each business day X #litres used per end-of-day rinse) + (average # paint changes per day X #litres used per pre-paint change rinse)] X #business days worked

The spray department supervisor advises that:

- he uses 3.8 litres of mineral spirits for each machine cleaned at the end of each business day
- on average, half of the machines rinsed at the end of the business day were applying basecoats and the other half were applying topcoats
- he uses half this amount (or 1.75 litres) of mineral spirits for each spray system cleaned prior to a paint change
- he conducts on average 2 paint changes on each of two machines each business day
- all paint changes are for topcoats (as they are tinted in varying colours)
- end-of-day rinse solvent is recaptured and reused a second time

Company records indicate the facility operated 220 days in year 2011 and an average of 4.5 spray machines were in operation.

Usage of mineral spirits used for rinsing are as follow:

$$\begin{aligned} \text{Used for end-of day rinsing} &= 0.5 \times 4.25 \text{ machines} \times 3.8 \text{ litres} \times 210 \text{ days/year} \\ &= 1,695.8 \text{ litres} \times .760 \text{ kg/litre} \\ &= 1,288.8 \text{ kg} \end{aligned}$$

$$50\% \text{ used for basecoat rinsing} = 0.5 \times 1,288.8 = 644.4 \text{ kg}$$

$$50\% \text{ used for basecoat rinsing} = 0.5 \times 1,439.0 = 644.4 \text{ kg}$$

$$\begin{aligned} \text{Used before paint changes} &= 2 \text{ machines} \times 1.75 \text{ litres} \times 2 \text{ rinses per day} \times 210 \\ &\text{days/year} \\ &= 1,470 \text{ litres} \times .760 \text{ kg/litre} \\ &= 1,117.2 \text{ kg} \end{aligned}$$

Accordingly, mineral spirits used for rinsing topcoats is  $644.4 + 1,117.2 = 1,761.6 \text{ kg}$   
equipment =  $1,288.8 + 1,117.2 = 2,406.0 \text{ kg}$

As noted in Table F2, the amounts of mineral spirits that exited the process are as follows:

$$\text{Int1} = 0.0 \text{ kg}; \text{Int2} = 3,261.7 \text{ kg}; \text{Int3} = 3,684.8 \text{ kg}; \text{Int4} = 1,281.0 \text{ kg}; \text{Int5} = 335.2 \text{ kg}$$

The input usage amount (U) of 9,134 kg is different from the output amount (Int1+Int2+Int3+Int4+Int5) of 8,563 kg, by 571 kg difference. 788 kg of mineral spirits was added to inventory, reducing the difference to 217 kg. This difference can be attributed to fact that input amounts are based on purchasing and inventory records (which are precise) whereas output amounts are based on cost accounting, and engineering calculations (which are based on estimated production rates, average reduction rates/paint concentrations, etc.). In addition, some inaccuracy in the output calculations is expected as plant operating records are not always completed as

accurately as management would like and because some calculations are based on the memories and “best guess” estimates of the painting department supervisors.

### PRETREATMENT PROCESS

Mineral spirits was not used in the Pretreatment Process. Accordingly:

Int1 = 0 (used)

A2 = 0 (released to air)

Dis2 = 0 (disposed of)

Rec1 = 0 (recycled internally for reuse)

### PAINT PREPARATION PROCESSES

Paint mix for use in a spray or flowcoating application is blended in or in front of the Paint Storage Room in open containers. The open pails of paint mix are transported by hand or using a dolly to the spray booth or flowcoater. Mineral spirits is released to air during the time that paints and solvents are being dispensed and transported to the work station. If material spills from a pail during dispensing or transport, mineral spirits is released to air from the spilled material and from rags used to wipe up the spill. Mineral spirits remaining in the rags is disposed of when the rags are discarded.

Process input/output balance calculations:

Spray Paint Basecoat Preparation Process:  $\text{Int2} = \text{Int6} + \text{A3} + \text{Dis3}$

Spray Paint Topcoat Preparation Process:  $\text{Int3} = \text{Int7} + \text{A4} + \text{Dis4}$

Flowcoat Paint Basecoat Preparation Process:  $\text{Int4} = \text{Int8} + \text{A5} + \text{Dis5}$

Flowcoat Paint Topcoat Preparation Process:  $\text{Int5} = \text{Int9} + \text{A6} + \text{Dis6}$

**a) Mineral spirits that enters the process (Int2, Int3, Int4+Rec1, Int5):**

Int2 = 3,261.7 kg; Int3 = 3,684.8 kg; Int4 = 1,281.0 kg; Int5 = 335.2 kg.

The quantity Int3 represents the total amount of mineral spirits used in topcoat paints, plus the amount of mineral spirits used to rinse spray guns and paint lines. Refer to Solvent Receiving and Storage and Pretreatment Processes, above.

**b) Mineral spirits exiting the process (Int6+A3+Dis3, Int7+A4+Dis4, Int8+A5+Dis5, Int9+A6+Dis6):**

Some small amount of mineral spirits that enters the process may evaporate when paint is dispensed and blended or when paint mix is spilled during dispensing/blending and transport to the painting machine and from rags used to clean up this spill (collectively  $A_x$ ). Any mineral spirits remaining in the rags is discarded along with the rags ( $\text{Dis}_x$ ). No measurements are taken or records maintained to record spills because a spill occurs infrequently and involves a relatively small and insignificant amount of paint. Mineral spirits generally has a low to moderate evaporation rate (vs nBA) and pails are not left open for more than a few minutes at a time so the amount of a

solvent lost through evaporation in this process is not significant, measured or recorded.

(i) *Quantification Method : Combination of Mass Balance and "Best Guess" Estimates*

Mass Balance because input amounts equal or almost equal output amounts. The amounts of mineral spirits exiting to air or disposed of are provided from the memory and opinions of departmental supervisors.

(i) *Best Available Method Rationale:* No data is recorded concerning the frequency and volume of spilled paints so this information is based on the memory and opinions of the painting department supervisors.

(ii) *Data Quality:*

Because the output mass of mineral spirits is almost equal to input mass (i.e. significant loss to spills is not experienced), the quality of the data for the process output is no better or worse than that of the input. Accordingly the data is considered "Average".

(iii) *Calculations of total mass of mineral spirits that exits the process:*

Assumptions:

- No amount of mineral spirits released to air during dispensing and transport unless a spill occurs
- Spills occur on average once per week during blending or transport
- Each spill involves approximately one litre of paint mix
- Paint spills are distributed among paints/processes in accordance with their relative usages.

The formula for calculating mass of mineral spirits exiting the process due to spills is as follows:

kg mineral spirits used = (49 spills per year) x (distribution factor for paint/process combination) x (1 litre of paint mix per spill) x (% of paint mix that is mineral spirits) x (density of mineral spirits)

Calculations for the amounts of mineral spirits exiting the process on account of spills are shown in Table F3. These amounts (in kg) are as follows:

$$(A3+Dis3) = 4.9 \text{ kg}, (A4+Dis4) = 3.8 \text{ kg}, (A5+Dis5) = 2.0 \text{ kg}, (A6+Dis6) = 0.7 \text{ kg}$$

Amounts exiting each process which are in turn inputs for subsequent painting processes are as follows:

Spray Paint Basecoat Preparation	Int6 = Int2 - A3 - Dis3 = 3,261.7 - 4.9 = 3,256.8 kg
Spray Paint Topcoat Preparation	Int7 = Int3 - A4 - Dis4 = 3,684.8 kg - 3.8 kg = 3,681.0 kg
Flowcoat Paint Basecoat Preparation	Int8 = Int4 - A5 - Dis5 = 1,281.0 - 2.0 = 1,279.0 kg

Flowcoat Paint Topcoat Preparation  $\text{Int9} = \text{Int5} - \text{A6} - \text{Dis6} = 335.2 - 0.7 = 334.5 \text{ kg}$

## SPRAY PAINTING AND FLOWCOATING PROCESSES

In both spraying and flowcoating processes, mineral spirits is released to air in/from the painting machine while paint mix is being applied onto components and from the uncured coating on components that have been painted and which are being staged for the subsequent convection curing process. In the spray painting process, some amounts of mineral spirits are released to air from daily and periodic machine maintenance operations and from the disposal of associated waste materials. In the flowcoating process, some amounts of mineral spirits are released from paint remaining in the paint sump when the flowcoater is not in use. Releases/disposals are quantified as (A7+Dis7) from spray painting basecoats, (A8+Dis8) from spray painting topcoat, A9 from flowcoating basecoats and A10 from flowcoating topcoats.

As noted, mineral spirits is used in rinsing spray paint lines before paint changes and to clean each machine at the end of each business day.

Process input/output balance calculation:

Basecoat Spray Painting Process:	$\text{Int6} = \text{Int10} + \text{A7} + \text{Dis7}$
Topcoat Spray Painting Process:	$\text{Int7} = \text{Int11} + \text{A8} + \text{Dis8}$
Basecoat Flowcoating Process:	$\text{Int8} = \text{Int12} + \text{A9} + \text{Rec2}$
Topcoat Flowcoating Process:	$\text{Int9} = \text{Int13} + \text{A10}$

### a) Mineral spirits that enters the process (Int6, Int7, Int8+Rec1, Int9):

$\text{Int6} = 3,256.8 \text{ kg}$ ,  $\text{Int7} = 3,681.0 \text{ kg}$ ,  $\text{Int8} = 1,279.0 \text{ kg}$ ,  $\text{Int9} = 334.5 \text{ kg}$ . Refer to Paint Preparation Process (b)(iv), above.

### b) Mineral Spirits exiting the process (Int10+A7+Dis7, Int11+A8+Dis8, Int12+A9, Int13+A10):

The greatest amount of mineral spirits exiting the process is released to air during paint application. A lesser amount exiting the process is contained in uncured paints on parts that are moved to the Curing Process (int10, Int11, Int12, Int13). Less significant amounts of mineral spirits evaporate from the surface of coated parts collecting on carts (until the carts are filled at which time they are moved to the curing oven and are released/disposed of from maintenance activities).

#### (i) Best Available Method Rationale:

A common convention used in the painting industry is that 80% of solvents are released from an applied coating during the coating process with the remaining 20% released during the curing process. This analysis uses this convention to determine the mass of mineral spirits exiting the process and moving to the Curing Process. Because no data is available to quantify heptane exiting the process from maintenance

activities or from uncured coating on standing parts, amounts of releases to air and disposals are calculated in the aggregate.

*(ii) Data Quality:*

The quality of the data is considered “Average” because the analysis uses a common industry convention which does not take into account the specific processes and materials used at VML.

*(iii) Calculations of total mass of heptane that exits the process:*

Convention: 80% of mineral spirits in applied paint is released in the process and 20% is released in the subsequent curing process.

Amounts exiting each process are as follow

Basecoat Spray Painting Process:	$\text{Int}_{10} = 0.2 \times \text{Int}_6 = 0.2 \times 3,256.8 = 651.4 \text{ kg}$
	$(\text{A}_7 + \text{Dis}_7) = .8 \times \text{Int}_6 = 2,605.4 \text{ kg}$
Topcoat Spray Painting Process:	$\text{Int}_{11} = 0.2 \times \text{Int}_7 = 0.2 \times 3,681.0 = 736.2 \text{ kg}$
	$(\text{A}_8 + \text{Dis}_8) = 0.8 \times \text{Int}_7 = 2,944.8 \text{ kg}$
Basecoat Flowcoating Process:	$\text{Int}_{12} = 0.20 \times \text{Int}_8 = 0.20 \times 1,279.0 = 255.8$
	$\text{A}_9 = 0.8 \times \text{Int}_8 = 1,023.2 \text{ kg}$
Topcoat Flowcoating Process:	$\text{Int}_{13} = 0.2 \times \text{Int}_9 = 0.2 \times 334.5 = 66.9 \text{ kg}$
	$\text{A}_{10} = 0.8 \times \text{Int}_9 = 267.6 \text{ kg}$

## SPRAY PAINT AND FLOWCOAT PAINT CURING PROCESSES

All painted coatings are full cured in a convection oven and it is assumed that 100% of mineral spirits entering this process exits the process to air.

Process input/output balance calculation:

Spray Painting Basecoat Curing Process:	$\text{Int}_{10} = \text{A}_{11}$
Spray Painting Topcoat Curing Process:	$\text{Int}_{11} = \text{A}_{12}$
Flowcoating Basecoat Curing Process:	$\text{Int}_{12} = \text{A}_{13}$
Flowcoating Topcoat Curing Process:	$\text{Int}_{13} = \text{A}_{14}$

**a) Mineral spirits that enters the process (Int6, Int7, Int8, Int9):**

$\text{Int}_{10} = 651.4 \text{ kg}$ ,  $\text{Int}_{11} = 736.2 \text{ kg}$ ,  $\text{Int}_{12} = 255.8 \text{ kg}$ ,  $\text{Int}_{13} = 66.9 \text{ kg}$ . Refer to Spray Painting and Flowcoating Processes (b)(iv), above.

**c) Mineral spirits exiting the process (A11, A12, A13, A14):**

*(i) Best Available Method Rationale:*

Method is based on extensive observation and logic and is the only one that makes sense.

*(ii) Data Quality:*

Because the output mass of heptane is equal to input mass, the quality of the data for the process output can be no better than that of the input. Accordingly the data is considered "Average".

(iii) *Calculations of total mass of heptane that exits the process:*

Amounts exiting each process are the same as those entering the process as follows:

Spray Painting Basecoat Curing Process:	A11 = Int10 = 651.4 kg
Spray Painting Topcoat Curing Process:	A12 = Int11 = 736.2 kg
Flowcoating Basecoat Curing Process:	A13 = Int12 = 255.8 kg
Flowcoating Topcoat Curing Process:	A14 = Int13 = 66.9 kg

## FACILITY-WIDE ACCOUNTING

Although all use of mineral spirits by the facility is accounted for, as noted in (b)(iv) of the Solvent Receiving and Storage Process, there is a variance of 217 kg (4.6%) between the input usage amount (U) of 9,134 kg (reported to NPRI) and the output usage of 9,351 kg (i.e. 8,563 from painting operations plus 788 increase in inventory) This discrepancy is due to different procedures having been used for reporting NPRI emissions and for calculating usages in this TSRP. (See Solvent Receiving and Storage Process (b)(iv).)

Facility-level quantification data for mineral spirits used at Vacuum Metallizing Limited in year 2011 is outlined in Table F3.

### 7. *Opportunities for Reducing the Use of Mineral Spirits*

Refer to Master Document, Section 7 for a general discussion about opportunities for reducing solvent use at Vacuum Metallizing Limited, for a list of options that were considered and evaluated.

As noted in the Master Document, Options (i), "*Recapture, recycle offsite and re-use solvents used to rinse spray guns and paint lines*" and (j) "*Recapture and reuse solvent used to rinse spray guns and paint lines*" are identified as being technically and economically feasible. In year 2011 mineral spirits was used for rinsing spray guns and paint lines so these options only apply to this solvent. As noted in the Master Document, these options fall under the Option Categories "Onsite reuse or recycling" and "Training or improved operating practices".

### 8. *Economic Analysis of Opportunities for Reduction in Use of Mineral Spirits*

Direct cost: Annual purchases of mineral spirits: 9,134 kg x \$1.933/kg = \$17,656

Indirect Costs: Receiving and storing mineral spirits  
 Dispensing mineral spirits  
 Paying supplier Invoices  
 Building overheads associated with plant storage area  
 Equipment maintenance costs

Spill cleanup costs  
 Compliance reporting cost  
 Employee training cost  
 Personal Protective Equipment  
 Limitation on production output due to MOE emission limits

The following are economic evaluations for each of the options identified as potentially reducing the use of mineral spirits. Note that for each option, the possible impact of each of the above indirect costs was considered and that where an indirect cost does not appear in the analysis, it was determined that the indirect cost had a negligible impact, or that the indirect cost was not applicable to the subject option.

i) Option (c): Replace mineral spirits with non-voc solvent

Technical Evaluation: Testing will be required. Likely technically feasible for sprayed coatings which account for greatest majority of usage.  
 Possible difficulty using non-voc solvents for flowcoating applications.

Economic Evaluation:

Assume same volume of mineral spirits and of replacement solvent would be required.

Cost of mineral spirits non-voc replacement solvent:  
 $= 9,134 \text{ kg} \div 0.755 \text{ kg/l} = 12,098 \text{ litres} \times \$3.05/\text{litre (estimate)} = \$36,898.$

The increase in cost associated with Option (c) (before supplier markups) would be  $\$36,898 - \$17,656 = \$19,212.$

Identified potential indirect cost savings and an evaluation of each are as follows:

Potential Savings: Ability to increase production output without exceeding MOE emission limits

Evaluation: *No impact as company is operating under the limit and is unlikely to exceed it.*

Potential Savings: Reduced compliance reporting costs.

Evaluation: *Cost would not decrease with the implementation of this option because replacements are not available for all toxic substances used at the facility so compliance reporting would still be required. In addition, the cost of compliance reporting is not variable because reporting is performed by the company president who whose pay would remain the same regardless of whether or not he performs this function or how many hours he works.*

Conclusion: *Option is not economically feasible because it would result in significant increase in cost.*

The following are the technical and economic evaluations of the two options:

- (ii) Option (i): Recapture, recycle offsite and re-use solvents used to rinse spray guns and paint lines

Technical Evaluation:

The current practice for purging/rinsing spray guns and paint lines is to replace the paint mix in the paint pot with mineral spirits and to spray the solvent through the paint system into the spray booth's water wash. The purge material captured in the water wash evaporates over time and is lost to air as the wash is aerated. If during the rinsing procedure the spray gun paint cap is removed, the solvent will leave the gun in a stream rather than being atomized. Before rinsing the paint delivery system, paint mix is purged from the paint lines and returned to the paint pot. By placing a valve and "T" in the paint line, the solvent delivered through the paint line can be directed into a collection container. The collected solvent rinse would be sent off-site for recycling and repurchased from the recycler for re-use in paints or for its original purpose of rinsing paint lines and paint guns.

Economic Evaluation:

A solvent recycler has inspected a typical sample of rinse and indicates that the rinse contains 5% solids by volume.

Data inputs for calculations:

- the annual mass of mineral spirits is 2,406 kg, which equates to 3,145 litres assuming density of 0.765 kg/litre.
- rinse solvent is recycled once three drums have been filled
- amount of solvent other than mineral spirits in the paint mix is negligible
- drums will contain 95% mineral spirits and 5% solids
- cost for recycling per recycler's quotation is
  - \$120 flat rate transportation fee
  - \$70.00 per drum recycling fee
  - \$1.00 per litre of sludge requiring disposal
  - \$200 per drum solvent repurchase
- Cost for modifying spray systems to facilitate solvent recapture is estimated as \$297 as follows:
  - Valves, fittings and hose 6 machines x \$75 per machine = \$225
  - 30 minutes labour x 6 machines x \$24 per hour = \$72
- Indirect costs or savings associated with implementation are insignificant (In reality, it is likely that recycling rinse solvent will increase labour costs with little or no savings in spray booth maintenance, compliance or other costs plus there is the administrative cost of shipping the drums and paying supplier invoices. The company is prepared to absorb these costs so this analysis sets a zero value on them.)

Three drums of rinse will contain 615 litres of which 584 litres (95%) will be mineral spirits and 31 litres (5%) will be sludge. The cost for recycling the three drums of mineral spirits and repurchasing the distillate is:

$$\$120 + (3 \times \$70) + (31 \times \$1.00) + (3 \times \$200) = \$961$$

Price per kg for recycling and repurchasing 3 drums of mineral spirits =  $\$961 \div 584 = \$1.65$  per kg.

The company's solvent supplier charges \$1.86 per kg plus \$49.00 per delivery and a typical order contains 8 drums.

The amount the company will save on purchasing 584 litres of recycled mineral spirits vs. purchasing new solvent is calculated as:

$$584 \times \$1.86 + \$49/8 \text{ drums} - \$961 = \$131.37.$$

The company would likely recycle 3 drums of mineral spirits twice per year so the annual savings would be \$262.74. Accordingly, if this option were to be implemented by itself (i.e without also implementing Option (j)) the payback period would be  $297 \div 263 = 1.13$  year, or about 13 ½ months.

Assuming the company also implements Option (j) and reuses the rinse once before recycling it, the rinse would contain as much as 7.5% solids. In this case, of the 615 litres sent for recycling only 569 litres (92.5%) would be returned and 46 litres would be disposed of and the cost for recycling the three drums of mineral spirits and repurchasing the distillate is:

$$\$120 + (3 \times \$70) + (46 \times \$1.00) + (3 \times \$200) = \$976$$

In this case the price per kg for recycling and repurchasing 3 drums of mineral spirits =  $\$976 \div 569 = \$1.72$  per kg.

The savings for repurchasing the distillate is:

$$569 \times 1.86 + \$49/8 - \$976 = \$88.47$$

This savings would be in addition to the savings associated with any savings arising from implementation of Option (j). Accordingly the company plans to implement this option.

(iii) Option (j): Recapture and reuse solvent used to rinse spray guns and paint lines

Solvent used to rinse spray guns and paint lines would be recaptured as described in Option (i), above. Approximately 8 drums of mineral spirits are used for day-end rinsing.

It will take about 5 months to collect enough rinse to justify recycling. Accordingly, this analysis assumes that half the mineral spirits used for day-end rinsing during the year will be fresh solvent and half will be recycled. The cost per kg would therefore be  $0.5 \times (1.86 + 1.72) = \$1.79$ .

Implementing Option (j) alone (i.e. without implementing Option (i), the solvent cost per day-end rinse is equal to the savings (as half the rinse will be used/saved with the rinse being used twice before being discarded) is:

$$3.8 \text{ litres/rinse} \times .765 \text{ kg/litre} \div 2 = 1.45 \text{ kg} \times \$1.86/\text{kg} = \$2.697/\text{rinse}$$

The annual solvent cost for rinsing 4.25 machines 210 days per year would be:

$$\$2.697 \times 4.25 \times 210 = \$2,407$$

The associated payback period would be  $297 \div 2407 = 0.123$  year, or 1.5 months.

Replacing half the mineral spirits with recycled solvent the annual solvent cost for rinsing would be:

$$0.5 \times 3.8 \text{ litres} \times 4.25 \text{ machines} \times 210 \text{ days/year} \times .765 \text{ kg/litre} \times \$1.79/\text{litre} = \$2,322.$$

Annual savings associated with implementing Option (i) and Option (j) is:

$$2 \times \$2,407 - \$2,322 = \$2,492$$

The associated payback period would be  $297 \div 2492 = 0.119$  year, or about 1.4 months.

The company intends to implement this option.

iii) Option (I): Purchase paints in smaller quantities:

This option would reduce the amount of mineral spirits received and held in inventory by reducing the number of drums of 33C36, AB35, 3003 and 3001 paints purchased at any one time from each of three suppliers and held in inventory.

Estimated annual direct savings associated with a 50% decrease in purchase amounts:

On average, amount of paint used and purchased would be unchanged	(\$ 0)
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Estimated annual indirect savings:

Capital cost saving associated with reduction:	
2 drums 33C36 @ \$2,628 ea. x 2.0%	(\$105)
2 drums 3001 @ \$1,200 ea. x 2.0%	( 48)
2 drums of AB35 @ \$1,705 x 2.0%	( 68)
2 drums of 3003 @ \$1,837 x 2.0%	( 73)
Total savings from freed-up capital	( 294)

Savings from freed-up inventory area	(\$ 0)
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Total savings	(\$294)
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Cost increases associated with making six additional paint shipments per year (2 per supplier):

Freight @ \$450 per shipment	\$2,700
Generate six additional invoices per year @ \$25 ea.	150

**Certification by highest-ranking employee of the facility having management responsibilities relating to the facility:**

I, Jeffrey Sugar, certify that during 2012, a review of the toxic substance reduction plan for mineral spirits was conducted in accordance with the *Toxics Reduction Act, 2009* and Ontario Regulation 455/09 (General) made under that Act. As of December 15, 2012, I also certify that I have read the toxic substance reduction plan dated December 15, 2012 for mineral spirits and am familiar with its contents and to my knowledge the version of the plan is factually accurate and complies with the *Toxics Reduction Act, 2009* and Ontario Regulation 455/09.



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Jeffrey Sugar, President  
Vacuum Metallizing Limited

Receive six additional shipments per year - 20 minutes each @ \$20/hr.	40
Total cost increases	<u>2,890</u>
Net cost increase/(decrease)	\$ 2,596

*Evaluation: Implementation of option would increase cost without reducing usage.*

*Conclusion: Option is not economically feasible.*

As noted, Option (d) "Replace HVHP spray guns with more efficient LVLP or LVHP spray guns" is to be evaluated and results included in the June 1<sup>st</sup> TSRP update.

The company will continue to monitor the availability and cost of a non-voc replacement for mineral spirits and will include updated evaluation(s) in the TSRP updates.

### 9. **Implementation of Opportunities for Reducing the Use of Mineral Spirits**

The following is the company's schedule for implementing options (i) and (j) to reduce use of mineral spirits and associated purchase cost:

ACTIVITY	COMPLETE BY
• Source fittings and components for modifying paint lines to allow rinse recapture	December 15, 2012
• Complete modifications to painting equipment and begin to reuse and collect rinse	January 10, 2013
• Send sample rinse solvent to recycler for evaluation and analysis	January 20, 2013
• Receive confirmation from recycler. Begin to collect rinse for recycling	January 30, 2013
• Send collected rinse to recycler	May 31, 2013

### 10. **Certifications**

#### **Certification by Toxic Reduction Planner:**

As of Dec. 18, 2012, I Kaleem Muhammad certify that I am familiar with the processes at Vacuum Metallizing Limited that uses or creates the toxic substance mineral spirits, that I agree with the estimates referred to in subparagraphs 7 iii, iv and v of subsection 4(I) of the *Toxics Reduction Act, 2009* that are set out in the plan for mineral spirits dated December 15, 2012 and that the plan complies with the act and Ontario Regulation 455/09 (General) made under that Act.



Kaleem Muhammad License #TSRP0252

TABLE F1

CALCULATION OF THE MASS OF MINERAL SPIRITS ENTERING THE PROCESS

Paint Purchases	CAS	Volume Per Container (litres)	No. Containers Received	Paint Usage (litres)	MS by Volume (%)	MS Usage (litres)	Density of MS (kg/litre)	MS Usage (kg)	Starting Inventory	Ending Inventory	Inventory Incr/(Decr)	
											Units	(kg MS)
33C36	8032-32-4	205.0	8	1,640	10.0%	164	0.750	123	1.0	1.0	0.0	0
AB35	64742-48-9	208.2	15	3,123	54.5%	1702	0.760	1294	1.0	3.0	2.0	150
VB226	64742-89-8	208.2	7	1,457	31.7%	462	0.750	346	1.0	1.0	0.0	0
	8032-32-4											
3001	8032-32-4	208.2	14	2915	13.4%	391	0.750	293	2.0	3.0	1	21
3003	64742-48-9	208.2	24	4997	65.0%	3248	0.760	2468	1.0	7.0	6	617
SW7000	64742-88-7	1.0	26	25	1.4%	0	0.868	0	0.0	0.0	0	0
Multi 4U	64742-48-9	205.0	1	205	73.8%	151	0.760	115	0.0	0.0	0	0
	64742-48-9	18.9	13	246	2.5%	6	0.760	5	2.0	2.0	0	0
PSCW-20L	64742-48-9	205.0	1	205	100.0%	205	0.760	156	0.0	0.0	0	0
Solvent	64742-48-9	190.7	17	3242	100.0%	3242	0.750	2431	1.0	1.0	0	0
Solvent	64742-89-8	208.1	7	1457	100.0%	1457	0.745	1085	1.0	1.0	0	0
Solvent	64742-49-0	203.4	3	610	100.0%	610	0.772	471	0.0	0.0	0.0	0
	8052-41-3					12,100		9,134				788

**TABLE F2**

**AMOUNT OF MINERAL SPIRITS EXITING THE SOLVENT RECEIVING AND STORAGE PROCESS (AMOUNTS ENTERING SUBSEQUENT PROCESSES)**

PAINT	SUBSEQUENT PROCESS		MS IN MIX (%)	MIX PER PRODUCTION LOAD (litres)	MS PER PRODUCTION LOAD (litres)	DENSITY OF MS (kg/litre)	MS PER PRODUCTION LOAD (kg)	PRODUCTION LOADS	MS USED (kg)
33C36	Spray - Basecoat	8031-32-4	12.5%	2.62	0.33	0.772	0.25	922	233.2
	AB35/VB226	8032-32-4	5.5%	3.17	0.17	0.772	0.13		
		64742-89-8	18.6%	3.17	0.59	0.750	0.44		
3001/AB35	Subtotal AB35/VB226	64742-48-9	28.8%	3.17	0.91	0.760	0.69		
		8032-32-4	7.6%	3.80	1.68	0.909	1.52	849	1,293.3
	Spray - Basecoat	64742-89-8	11.0%	3.80	0.29	0.772	0.22		
	Subtotal 3001/AB35	64742-48-9	10.0%	3.80	0.42	0.750	0.31		
		64742-48-9		3.80	0.38	0.760	0.29		
3003	Spray - Basecoat	64742-48-9	32.5%	3.80	1.09	0.759	0.83	1114	919.3
SW 7000	Spray - Basecoat	64742-88-7	0.5%	0.57	1.24	0.760	0.94	55	51.6
Multi-4U	Spray - Basecoat	64742-48-9	60.0%	3.80	2.28	0.760	1.73	66	115.0
PSCW-20L	Spray - Basecoat	64742-48-9	1.7%	4.00	0.07	0.760	0.05	88	4.6
Rinsing	Spray - Basecoat	misc							
Subtotal	Spray - Basecoat								644.4
3003	Spray - Topcoat	64742-48-9	32.5%	3.80	1.24	0.760	0.94	2049	3,261.7
Rinsing	Spray Topcoat	misc							1,923.2
Subtotal	Spray Topcoat								1,761.6
33C36	Flowcoat - Basecoat	8052-41-3	12.5%	1.14	0.14	0.750	0.11		
		8032-32-4	5.0%	1.14	0.06	0.772	0.04		
	Subtotal 33C36		2.11	0.20	0.756	0.15	695	104.9	
AB35	Flowcoat - Basecoat	64742-48-9	36.3%	1.00	0.77	0.760	0.58	491	286.2
		64742-49-0	60.0%	1.00	0.17	0.76	0.13	1368	171.5
	Subtotal VISO/AB35	64742-89-8	10.0%	1.00	0.60	0.75	0.45	1368	615.8
				1.00	0.10	0.75	0.08	1368	102.6
Subtotal	Flowcoat - Basecoat							889.9	
33C36	Flowcoat - Topcoat	8052-41-3	11.0%	1.14	0.13	0.750	0.09		
		8032-32-4	3.3%	1.14	0.04	0.772	0.03		
	Subtotal 33C36		2.11	0.16	0.755	0.12	397	49.0	
AB35	Flowcoat - Topcoat	64742-48-9	36.3%	2.11	0.77	0.760	0.58	491	286.2
									335.2
TOTAL MS									8,562.7

TABLE F3

ALLOCATION AMONG PROCESSES OF MINERAL SPIRITS EXITING PAINT PREPARATION PROCESSES DUE TO SPILLS

PAINT DISPENSED IN PAILS	SUBSEQUENT PROCESS	PROCESS ID	TOTAL SPILLED MIX (litres)	DIST'N FACTOR	ALLOCATED SPILL VOLUME (litres)	MS IN SPILLED IN MIX (%)	ALLOCATED MS IN SPILLED PAINT (litres)	DENSITY OF MS (kg/litre)	MS IN SPILLED PAINT (kg)
33C36	Spray - Basecoat		49	0.09	4.41	12.5%	0.55	0.772	0.43
AB35/VB226	Spray - Basecoat					5.5%	0.30	0.772	0.23
	Subtotal AB35/VB226		49	0.11	5.39	18.6%	1.00	0.750	0.75
3001/AB35	Spray - Basecoat					28.8%	1.55	0.760	1.18
	Subtotal 3001/AB35		49	0.17	8.33	7.6%	0.63	0.772	0.49
3003	Spray - Basecoat		49	0.01	0.49	11.0%	0.92	0.750	0.69
SW 7000	Spray - Basecoat		49	0.0	0	10.0%	0.83	0.760	0.63
Multi-4U	Spray - Basecoat		49	0.0	0		2.38		1.81
PSCW-20L	Spray - Basecoat		49	0.0	0	32.5%	0.16	0.760	0.12
Subtotal	Spray - Basecoat	A3+Dis3	49			0.5%	0.00	0.760	0.00
3003	Spray - Topcoat	A4+Dis4	49	0.31	15.19	17.8%	0.00	0.760	0.00
33C36	Flowcoat - Basecoat					1.7%	0.00	0.760	0.00
	Subtotal 33C36		49	0.03	1.47		4.94		4.94
AB35	Flowcoat - Basecoat		49	0.04	1.96	36.3%	0.71	0.760	0.54
VISO/AB35	Flowcoat Basecoat					16.5%	0.32	0.76	0.25
	Subtotal VISO/AB35		49	0.04	1.96	60.0%	1.18	0.75	0.88
Subtotal	Flowcoat - Basecoat	A5+Dis5	49			10.0%	0.20	0.75	0.15
33C36	Flowcoat - Topcoat						1.70		1.27
	Subtotal 33C36		49	0.02	0.98		2.00		2.00
AB35	Flowcoat - Topcoat		49	0.04	1.96	11.0%	0.11	0.750	0.08
Subtotal	Flowcoat - Topcoat	A6+Dis6	49	0.04	1.96	3.3%	0.03	0.772	0.03
TOTAL MS						36.3%	0.71	0.760	0.54
									0.65
									11.35

TABLE F4

FACILITY-WIDE ACCOUNTING FOR MINERAL SPIRITS

Form of Involvement at the facility	PROCESS												All Processes			
	Solvent Receiving and Storage	Pretreatment	Spray Paint Basecoat Preparation	Spray Paint Topcoat Preparation	Flowcoat Paint Basecoat Preparation	Flowcoat Paint Topcoat Preparation	Basecoat Spray Painting	Topcoat Spray Painting	Basecoat Flowcoating	Topcoat Flowcoating	Spray Painting Basecoat Curing	Spray Painting Topcoat Curing	Flowcoating Basecoat Curing	Flowcoating Topcoat Curing		
Enters (use)	9134	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9134	0
Created		0.0	4.9	3.8	2.0	0.7	2604.5	2944.8	1023.2	267.6	651.4	736.2	255.8	66.9	8563	0
Released to air		incl.	incl.	incl.	incl.	incl.	incl.	incl.	incl.	incl.	incl.	incl.	incl.	incl.	incl.	
On-site disposal		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0
Released to land		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0
Released to water		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0
Off-site disposal		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0
Transferred for recycling off-site		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0
Contained is shipped product		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0
Transformed		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0
Destroyed at facility		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0
Unaccounted/Imbalance																
Remaining in storage	-217														788	

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***Toxic Reduction Planner's Recommendations:***

