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Application of Cost Effectiveness Methodology and Indicators for Use in Section 32 Requests under Ontario Regulation 419: Air Pollution – Local Air Quality

USER GUIDE

Total Resource Effectiveness (TRE) Methodology and Calculations

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Table of Contents

1.0 Introduction

Facilities preparing to submit a request for an alternative standard under Section 32 of Ontario Regulation 419: Air Pollution – Local Air Quality are required to identify and evaluate all feasible Point of Impingement (POI) reduction techniques and implement appropriate improvements. Some facilities may find it useful to consider economic factors in evaluating potential POI reduction techniques. The Ontario Ministry of the Environment (MOE or Ministry) engaged a study titled The Development of a Background Paper and the Application of Cost Effectiveness Indicators for Use in Section 32 Requests under Ontario Regulation 419:Air Pollution – Local Air Quality, OSS-076351 to develop a methodology and indicator values for considering economic factors. The study was completed in February, 2009.

The study resulted in development of a methodology for evaluating the cost effectiveness of potential POI reduction techniques. The methodology derives a dimensionless value that provides an indicator of Total Resource Effectiveness (TRE) for the POI reduction technique being evaluated. There are common elements that should be considered in estimating potential costs associated with the POI reduction technique and for scaling the health and environmental risks reduced. Standardized form(s) have been developed to aid the environmental professional in collecting, estimating and presenting the various elements needed to determine TRE values. This guide provides step-by-step instructions on how to complete a cost effectiveness evaluation using the TRE methodology and standardized form(s).

2.0 Description of Calculation Forms

The calculation form(s) have been created using Microsoft Excel spreadsheet(s). It is expected that most environmental professionals will be familiar with navigation, data entry and use of this system. The forms should be considered as tools to provide structure and provoke thinking regarding elements to consider when evaluating a potential POI reduction technique. Extensive use should be made of the space provided for comments and notes to fully explain estimates, assumptions and reasoning for each entry as necessary to clearly convey to potential reviewers and stakeholders the basis of the TRE evaluation.

The environmental professional is encouraged to add information to the forms as needed to completely reflect site specific potential costs related to the POI reduction technique being evaluated while retaining the key cost elements set-out in **bold** print on the forms (i.e. **Total Capital Cost (TCI)**, **Capital Recovery Cost (CRC)**, **Total Annual O & M Costs (OMC)**, **Total Annual Cost Savings (SAV)**, **Total Annual Revenue (REV)**, and **Net Total Annual Costs (TAC)**). Specific facility and source information required on the form(s) under the Emission Summary and Dispersion Modelling (**ESDM) Information** (items a. through i.) must not be revised and will normally represent values agreed to with the Ministry for the site specific POI reduction technique being evaluated.

Data entry in the form begins by identifying the facility and the process that are the subject of the TRE evaluation. Overwrite ***{Facility Name and Process}*** at cell B2 with site specific information. It may also be desirable to record a file name in this location to simplify future reference. Next, overwrite *{POI Reduction Technique}* at cell B3 with information regarding the option being evaluated (i.e. Coating Change – Powder, Applicator Change – Electrostatic, Carbon Adsorption Canister, Wet Electrostatic Precipitator, etc.). Now move to the right side, top of the form and annotate the *{Date}* at cell L2 and identify the contaminant being evaluated at cell L3 *{Contaminant Controlled}*. The top of the form should uniquely identify the TRE evaluation being performed.

The first step in evaluating the effectiveness of a potentially feasible[1] POI reduction technique in terms of resources required is to estimate the costs associated with obtaining, installing and operating the new technique. The POI reduction technique may involve a change to production materials, processes or adding/changing emission control devices. The forms have been created to identify generically most cost elements that would be considered in bringing a technology change into operation. It may be that not all of the identified elements are required for a particular POI reduction technique being evaluated, in which case they may be left blank (i.e. $0) with a comment that they do not apply or deleted from the form. In any event, each cost element identified on the form(s) should provoke the environmental professional to consider its' appropriateness and respond accordingly, with explanation (i.e. written comment or note annotated on the form) of rationale.

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1 In this document, the term POI reduction technique is similar to a pollution control option, strategy or combination(s) as defined in the Guide for Requesting an Alternative Air Standard (PIBS# 6322e).

For many material and process changes a deep and intimate knowledge of the operation and facility will be required to estimate the costs associated with a potential POI reduction technique. The environmental professional may find the elements listed on the form(s) useful in directing inquiry of site engineering and operational personnel in obtaining credible cost estimates. A generic TRE form (TRE calculation form general) identified as {*POI Reduction Technique*} at cell B3 has been developed for this purpose.

Regarding add-on emission control devices, without experience or guidance, estimating potential costs associated with purchasing, installing and operating equipment can be a daunting task. Fortunately, excellent reference material is available from the USEPA Office of Air Quality Planning and Standards (OAQPS) that provides direction on cost elements to consider and extensive survey information providing routine and customary pricing of many of the required elements for specific types of control devices. OAQPS' EPA Air Pollution Control Cost Manual (Sixth Edition), EPA/452/B-02-001 may be found at http://www.epa.gov/ttn/catc/dir1/c_allchs.pdf . The manual is periodically updated so it is recommended that the latest version be used. Even better cost estimates may be obtained by direct vendor quotes to purchase and install emission control devices. Unfortunately, it is not always a viable option (especially at the techniques evaluation stage).

3.0 Capital Cost

Changes to manufacturing operations involving material substitutions, process equipment changes or add-on emission control devices will almost always require initial investment or capital costs. Typically, capital costs may be divided into *Purchased Equipment Cost*, *Direct Installation Costs*, and *Indirect Installation Costs*. Specific elements to consider for each category of capital cost are included in the form(s) and descriptions of intent are provided below.

It is impossible to anticipate every potential POI reduction technique and develop specific cost estimates in advance. However, based upon USEPA's extensive survey of control devices and development of costing algorithms for specific types of equipment, it is possible to develop cost estimates for some control devices. Consequently, TRE forms have been developed for estimating costs associated with three (3) commonly used emission control devices (i.e. regenerative thermal oxidizers, pulse jet fabric filters, and venturi scrubbers). The forms are attached and

contain estimates for many cost elements based upon the volume of air requiring treatment and the anticipated operating schedule of the source being evaluated. The environmental professional may find these control device specific forms useful in obtaining relatively quick, directional cost estimates for completing a TRE evaluation.

Purchased Equipment Cost

Items a. through e. are intended to capture the costs associated with the purchase of the base equipment required to implement the POI reduction technique.

a. Control Device

Purchase cost is estimated for the primary equipment projected to achieve the POI reduction. This could relate to material handling equipment, new process equipment or an add-on emission control device. Typically, for add-on control devices this represents the base device such as a filter house, venturi scrubber or oxidizer without supporting equipment. From USEPA's OAQPS manual, extensive surveys of equipment manufacturers and purchasers of equipment have resulted in regression formulas to approximate the cost of equipment based upon the quantity of air being handled. An environmental professionals' judgment is required to make reasonable assessments of source characteristics and appropriate equipment types, but directional cost estimates are obtainable. A couple of examples are listed below;

Regenerative Thermal Oxidizer: $2.204 \times 10^5 + 11.57$ (air flow, CFM) = RTO Cost ($)

Pulse-Jet Type Fabric Filter House: 2,307 + 7.163 x (air flow, CFM) = FH Cost ($)

Venturi Scrubber: 150 x (air flow, CFM) x 1.40 {stainless steel factor} = VS Cost ($)

Care should be taken in using these regression formulas since they apply to only very specific source conditions and characteristics. Additional factors may also be needed to completely estimate the control device cost (i.e. the filter house cost estimate does not include the cost of required filters or the cages needed to hold the filter material in position). Other regression formulas may be more appropriate based upon an environmental professionals' judgment. These formulas illustrate how cost estimates may be obtained using readily available source data, further

direction may be obtained by consulting USEPA's OAQPS Air Pollution Control Cost Manual (http://www.epa.gov/ttn/catc/dir1/c_allchs.pdf).

Other sources of information (including direct vendor quotes) may be used to estimate equipment costs. It is important that the source and content of the estimate be clearly identified and recorded using the comment section, foot notes or attaching reference material.

b. Auxiliary Equipment

This item represents an estimate of the cost associated with completing the initial purchase of equipment needed to allow the POI reduction technique to function. For example, this could include the cost of providing paint line heating if the POI reduction technique being evaluated involves changing from low solids to high solids content coating. For add-on control devices, this could include components such as hoods/enclosures, ductwork, motors, fans, valves, exhaust stacks, safety by-pass equipment, etc. The OAQPS Control Cost Manual contains formulas and techniques for estimating costs for many of these items. Vendor quotes for supplying control devices and other process equipment often include these items in the direct purchase price and estimates may not be required separately.

Auxiliary equipment can typically range from 80 to 120 percent of control device costs with even higher percentages expected as the primary device gets smaller. Components being included and the basis for the cost estimate(s) should be clearly identified and recorded using the comment section, foot notes or by attaching reference material.

c. Instrumentation

Often POI reduction techniques involve complex mechanical equipment requiring electronic and/or computerized instrumentation to control. Occasionally, continuous emission monitors or process monitors (temperature, leak detection, etc.) are required and cost estimates are included here. For add-on emission control devices, instrumentation costs may be included with the control device, especially if the cost estimate is from a vendor quote for 'off-the-shelf' equipment. According to USEPA's OAQPS manual, typical cost could be about 10 percent of cost of the control device and auxiliary equipment combined and this value has been incorporated in the TRE forms for add-on control devices. The environmental professional should consider the appropriateness of instrumentation for the specific

POI reduction technique being evaluated and the need for a separate cost estimate and record the assessment here.

d. Taxes

Sales taxes apply for most equipment purchases. In Ontario, PST and GST have been estimated at 13 percent of equipment cost.

e. Freight

The cost of shipping equipment needs to be included in the purchased cost estimate. Depending on the size and distance that equipment must be shipped, this can be a significant cost item. According to USEPA's OAQPS manual, typical cost has been estimated at 5 percent of cost of the control device and auxiliary equipment combined and this value has been incorporated in the TRE forms for add-on control devices. The environmental profession should evaluate the reasonableness of this estimate given the facilities location and the shipping distance of equipment and record acceptance or adjustments as appropriate.

Base Price (C)

The base price (C) of purchased control equipment is then the sum of items a. through e. and is automatically computed on the TRE forms. This is an important value for estimating direct and indirect installation costs of add-on emission control devices. Based upon USEPA's extensive survey of equipment suppliers and purchases, routine and customary costs have been estimated for specific elements related to installation of equipment based upon the type of equipment being installed and the estimated base price (C). These typical values have been incorporated into the control specific TRE forms. The control device TRE forms will automatically calculate cost estimates for each installation element based upon these typical values. The environmental professional should evaluate each estimate relative to site-specific conditions and record acceptance or adjustments as appropriate.

Direct Installation Costs

These represent costs directly associated with preparing, placing, connecting and otherwise installing equipment necessary to make the POI reduction technique ready for operation. The elements identified in the TRE forms are those that may be typically expected to be associated with equipment installations. The items listed may provoke consideration regarding their relevance to the particular POI reduction technique being evaluated and provide a record of the environmental professionals' judgment concerning appropriate cost estimates. It is important that the basis for the estimate(s) be clearly identified and recorded on the form using the space provided for comments and notes or by additional attachments if needed.

f. Foundation and Support

Process equipment and control devices, ducts, stacks, etc. are often large and heavy requiring addition of structural foundations and supports. Frequently equipment is placed on building roofs requiring installation of reinforced columns and structural steel trusses, etc. Typical costs are estimated at 4, 6 and 8 percent of the base price for filter houses, venturi scrubbers and thermal oxidizers, respectively. Oxidizers being relatively smaller and heavier require slightly more structural support. These values are based upon USEPA OAQPS manual estimates and have been incorporated into control specific TRE forms for the environmental professionals' consideration.

g. Handling and Erection

Equipment must be delivered, staged and installed. Cranes must be used to move large and/or heavy components, and welding, bolting and fitting must be completed. Typical costs are estimated at 50, 40 and 14 percent of the base price for filter houses, venturi scrubbers and thermal oxidizers, respectively. Filter houses typically involve far more field construction and fabrication than oxidizers that are largely shop fabricated and shipped ready to install. These values are based upon USEPA OAQPS manual estimates and have been incorporated into control specific TRE forms for the environmental professionals' consideration.

h. Electrical

Electrical service must be provided and connected to power motors and instruments. This item includes wiring, buses, switches and transformers required to service the equipment as well as the electricians to perform the work. Typical costs are estimated at 8, 1 and 4 percent of the base price for filter houses, venturi scrubbers and thermal oxidizers, respectively. These values are based upon USEPA OAQPS manual estimates and have been incorporated into control specific TRE forms for the environmental professionals' consideration.

i. Piping

Gas lines, stream lines, compressed air, water lines (including fire suppression) and drain lines may be required. Typical costs are estimated at 1, 5 and 2 percent of the base price for filter houses, venturi scrubbers and thermal oxidizers, respectively. These values are based upon USEPA OAQPS manual estimates and have been incorporated into control specific TRE forms for the environmental professionals' consideration.

j. Insulation

Ductwork and/or piping may require insulation for thermal efficiency or condensation control. Typical costs are estimated at 7, 3 and 1 percent of the base price for filter houses, venturi scrubbers and thermal oxidizers, respectively. These values are based upon USEPA OAQPS manual estimates and have been incorporated into control specific TRE forms for the environmental professionals' consideration.

k. Painting

Corrosion protection painting of structural elements, some ducts, piping, tanks, control device, etc. may be required. Typical costs are estimated at 4, 1 and 1 percent of the base price for filter houses, venturi scrubbers and thermal oxidizers, respectively. These values are based upon USEPA OAQPS manual estimates and have been incorporated into control specific TRE forms for the environmental professionals' consideration.

l. Site Preparation

Primarily the cost associated with clearing obstructions and making space available to receive the new equipment. This is completely site specific and no attempt has been made to estimate routine or customary values. Site specific justification is required to estimate costs and the basis and judgment of the environmental professional should be recorded on the TRE form.

m. Facilities & Buildings

Occasionally significant 'infrastructure' type work is needed to accommodate new equipment. Items such as control device waste handling equipment, boilers to make steam, compressors for air, building additions to house sensitive equipment, etc. Similar to Site Preparation, this is a completely site specific item and no attempt has been made to estimate routine and customary values. Site specific justification is required to estimate costs and the basis and judgment of the environmental professional should be recorded on the TRE form.

n. Retrofit Costs

Installation of new equipment into an existing facility can lead to major design and installation changes. Issues such as not enough room to install equipment or special provisions to accommodate available room are related to retrofit. Retrofit costs are not contingencies, which are unexpected costs related to purchasing and installing equipment (addressed elsewhere). Usually carried as a percentage of the base equipment cost, USEPA has retrofit costs as high as 30 to 50 percent for some add-on emission control device situations in the OAQPS manual. Higher costs have been used in some USEPA MACT (Maximum Available Control Technology) standard development documents. Care must be taken in estimating retrofit costs so as to not double count costs. If extra costs are estimated for activities such as foundations, structural supports, erection, electrical, site preparation, facilities & buildings, etc. because of existing conditions then retrofit costs should be correspondingly lower. Site specific justification is required to estimate costs and the basis and judgment of the environmental professional should be recorded on the TRE form.

Total Direct Costs (DC)

The Total Direct Cost (DC) is then the summation of elements a. through n. and is automatically calculated in the TRE forms.

Indirect Installation Costs

In addition to the costs directly associated with installing equipment there are indirect costs. These are the 'behind the scene' costs that can add significantly to the cost of bringing a POI reduction technique into operation. Similar to direct installation costs, the elements identified in the TRE forms are those that may be typically expected to be associated with equipment installations. The items listed may provoke consideration regarding their relevance to the particular POI reduction technique being evaluated and provide a record of the environmental professionals' judgment concerning appropriate cost estimates. It is important that the basis for the estimate(s) be clearly identified and recorded on the form using the space provided for comments and notes or by additional attachments if needed.

o. Engineering

Design and field support for installation. Typical costs are estimated at 1, 10 and 1 percent of the base price for filter houses, venturi scrubbers and thermal oxidizers, respectively. These values are based upon USEPA OAQPS manual estimates and have been incorporated into control specific TRE forms for the environmental professionals' consideration.

p. Construction and Field Expenses

Costs associated with personnel and miscellaneous costs to fully install and commission the control system. Typical costs are estimated at 20, 10 and 5 percent of the base price for filter houses, venturi scrubbers and thermal oxidizers, respectively. Installation of filter houses is generally a more complicated process because of the greater level of field fabrication involved. These values are based upon USEPA OAQPS manual estimates and have been incorporated into control specific TRE forms for the environmental professionals' consideration.

q. Contractor Fees

This is contractor profit and is typically estimated to be about 10 percent of the base price of the equipment. These values are based upon USEPA OAQPS manual estimates and have been incorporated into control specific TRE forms for the environmental professionals' consideration.

r. Start-up

Cost associated with initial placing of the system into operation, adjustments and turn-over of functioning equipment to the facility. Typical costs are estimated at 1, 1 and 2 percent of the base price for filter houses, venturi scrubbers and thermal oxidizers, respectively. These values are based upon USEPA OAQPS manual estimates and have been incorporated into control specific TRE forms for the environmental professionals' consideration.

s. Performance Test

Testing cost to assure emission control devices and the system functions as purchased. . Typical costs are estimated at 1 percent of the base price. Additional cost may be required for compliance testing to demonstrate performance to regulatory agencies and may be included in this item. These values are based upon USEPA OAQPS manual estimates and have been incorporated into control specific TRE forms for the environmental professionals' consideration.

t. Contingencies

Provision is provided for unanticipated cost increases. Typical costs are estimated at 3 percent of the base price. These values are based upon USEPA OAQPS manual estimates and have been incorporated into control specific TRE forms for the environmental professionals' consideration.

Total Indirect Costs (IC)

Total indirect cost (IC) is obtained by summing items o. through t. and is automatically calculated in the TRE forms.

Total Capital Investment (TCI)

The total cost to purchase and install a POI reduction technique is determined by the summation of C, DC and IC and is automatically calculated in the TRE forms.

Capital Recovery Costs (CRC)

The total capital cost represents a one-time investment in a POI reduction technique over the life of the equipment. It is desirable to convert the total capital cost to equal annualized cost for the purpose of completing the evaluation of the total resource effectiveness of the potential reduction measure. Using the amortization period of 10 years and interest rate of 6 percent provided in Section 2.5 of the Ministry's GIASO document (http://www.ene.go.on.ca/envision/gp/5166e02.pdf), the following multiplier is calculated.

$$i \; / \; \{ 1 - (1 + i)^{-n} \}$$

Where,

i = 6 % interest rate

n = 10 year equipment life

Then,

$$0.06 \; / \; \{ 1 - (1 + 0.06)^{-10} \} = \mathbf{0.13587}$$

The Capital Recovery Cost (CRC) is automatically calculated in the TRE forms by multiplying Total Capital Costs (TCI) by the annualizing factor above.

4.0 Annual Operating and Maintenance (O&M) Costs

Changes to manufacturing operations involving material substitutions, process equipment changes or add-on emission control devices will almost always involve

operating and maintenance costs. Similar to capital costs, operating and maintenance costs may be divided into *Direct Annual Costs*, and *Indirect Annual Costs*. Typically, operating and maintenance (O&M) costs are predictable and recurring and may be projected on an annual basis. Specific elements to consider for each category of annual O&M costs are included in the form(s) and descriptions of intent are provided below.

Labour and utility costs associated with POI reduction techniques may be difficult to estimate. It is impossible to anticipate every potential POI reduction technique and develop specific O&M cost estimates in advance. The environmental professionals' judgment is particularly important in developing creditable cost estimates. Some help is provided by USEPA's OAQPS manual in providing some typical labour hour estimates required for various emission control devices. However, labour rates and utility costs can be very much facility specific. Importantly, engineering estimates are possible for O&M with basic source information. When the POI reduction technique is an add-on emission control device, then the type of device, air volume treated and operating schedule provides enough information to develop reasonable O&M cost estimates. Consequently, TRE forms have been developed for estimating O&M costs associated with three (3) commonly used emission control devices (i.e. regenerative thermal oxidizers, pulse jet fabric filters, and venturi scrubbers). The forms are attached and contain estimates for many cost elements based upon the volume of air requiring treatment and the anticipated operating schedule of the source being evaluated. The environmental professional may find these control device specific forms useful in obtaining relatively quick, directional cost estimates for completing a TRE evaluation.

Direct Annual Costs

TRE forms have been developed for three commonly used emission control devices (i.e. regenerative thermal oxidizer, venturi scrubber and pulse-jet filter house). At the top of the form are spaces for recording air flow (at position D4) and operating hours (at position H4). This information will be combined with operational estimates obtained from USEPA's OAQPS manual, engineering judgment and Ontario specific utility rates to project O&M costs. Other methods of estimating O&M costs may be possible. The environmental professional must use judgment and record the basis for the estimates selected using the space provided on the form (i.e. comments, notes, or attachments).

a. Operating Labour (OL)

Annual costs are estimated by multiplying hours per year required to operate the POI reduction system or control device and hourly operating labor cost. For the three control device TRE forms, $30 per hour is used to estimate the hourly labor rate including direct pay and benefits. The source operating hours are entered at the top of the form(s) (position H4). Typical operating labor requirements for the control devices are estimated by USEPA's OAQPS manual at ½, 2 and 5 hours per shift for thermal oxidizers, filter houses and venturi scrubbers, respectively. The typical operating hours reflect the expectation that venturi scrubbers require far more operational attention than thermal oxidizers. The three control device TRE forms calculate this value automatically based upon operating hours indicated (at position H4). Foot notes have been annotated to the forms recording these assumptions. The environmental professional should evaluate each estimate relative to site-specific conditions and record acceptance or adjustments as appropriate. Other POI reduction systems would likely have different operational requirements and estimates would depend upon the environmental professionals' judgment.

b. Supervisory Labor (SL)

Annual cost estimate for direct supervision of control system operators should be provided. A reasonable estimate for supervision according to USEPA's OAQPS manual is obtained by using 15 percent of the operating labor cost and has been applied in the three control device TRE forms. The three control device TRE forms calculate this value automatically based upon operating labor cost (at position E40). The environmental professional should evaluate each estimate relative to site-specific conditions and record acceptance or adjustments as appropriate. Other POI reduction systems would likely have different operational requirements and estimates would depend upon the environmental professionals' judgment.

c. Maintenance Labour (ML)

This item provides an estimate of hours per year required to maintain the POI reduction system or control device multiplied by the hourly operating labor cost. For the three control device TRE forms, $40 per hour is used to estimate the hourly labor

rate including direct pay and benefits which is slightly higher than the operating labor rate to reflect the use of skilled trades. The source operating hours are entered at the top of the form(s) (position H4). Typical maintenance labor requirements for the control devices are estimated by USEPA's OAQPS manual at ½, 1 and 1.5 hours per shift for thermal oxidizers, filter houses and venturi scrubbers, respectively. The typical maintenance hours reflect the expectation that venturi scrubbers require more attention than thermal oxidizers. The three control device TRE forms calculate this value automatically based upon operating hours indicated (at position H4). Foot notes have been annotated to the forms recording these assumptions. The environmental professional should evaluate each estimate relative to site-specific conditions and record acceptance or adjustments as appropriate. Other POI reduction systems would likely have different maintenance requirements and estimates would depend upon the environmental professionals' judgment.

d. Maintenance Materials (MM)

Maintenance of equipment requires the consumption of a wide variety of routine replacement and consumable items such as oil & grease, nuts and bolts, hand tools, washers and gaskets, etc. An estimate of the annual cost for these items is provided here. For control devices, typical cost is estimated to be equivalent to maintenance labour cost according to USEPA's OAQPS manual. The three control device TRE forms calculate this value automatically based upon maintenance labour cost (at position E42). The environmental professional should evaluate each estimate relative to site-specific conditions and record acceptance or adjustments as appropriate. Other POI reduction systems would likely have different maintenance requirements and estimates would depend upon the environmental professionals' judgment.

Direct Labor Costs (D)

The Direct Labor Cost (D) is then obtained by the summation of elements a. through d. and is automatically calculated by the form(s).

e. Replacement Parts

The purchase of parts and components to replace worn out or broken equipment throughout the life expectancy of the equipment is estimated here. These are items beyond the consumable maintenance materials and include items such as replacement filters for a bag house, heat exchange media for a regenerative thermal oxidizer, spare motors and valves, bearings, VFD's, etc. In addition to larger components that are maintained in facility inventory to shorten repair time, long lead time spare parts may be in this estimate. Engineering judgment is required to consider and project a creditable range of replacement parts needed to maintain the POI reduction system in good working order. It is important that parts and components (and the basis for cost estimates) be clearly identified and recorded on the form using the space provided for comments and notes or by additional attachments if needed.

Utilities

An estimate should be provided to quantify the increased consumption of utilities to support operation of the POI reduction technology. These are recurring costs that can represent a significant element in evaluating the appropriateness of a potentially feasible control technique or technology. Generally, estimating utility costs will require a measure of engineering judgment without more detailed design information that is typically not available at the technology evaluation stage. Some examples include;

f. Natural Gas

Anticipated annual consumption multiplied by a unit cost. Fuel burning equipment such as thermal oxidizers used to destroy volatile organic contaminants can consume large quantities of natural gas. Based upon the size of a thermal oxidizer determined by the quantity of air flow being controlled a directional estimate of the amount of natural gas required and cost to operate the device may be obtained. For the thermal oxidizer TRE form, annual natural gas cost is automatically estimated based upon air flow (at position D4) and operating hours (at position H4). The calculation assumes that highly efficient thermal recovery devices will be used providing the capability of recovering all but 100^{o}F of the heating value of the

oxidizer operation. An estimate of the cost of natural gas has been made at $7.00 per MCF. Consequently, the following formula has been used to estimate cost;

(air flow, cfm) x (operating hours) x 100^{o}F x 1.08 x $7.00/1,000,000 BTU

The basis for the natural gas cost estimate and the assumptions used have been clearly recorded on the form. Similar estimates can be made for other POI reduction techniques.

g. Electricity

Anticipated annual consumption multiplied by a unit cost. Electricity is required to power lights, electronic components, motors, fans, pumps, etc. that may be associated with POI reduction techniques being evaluated. Fairly detailed engineering is typically needed to correctly quantify electrical demand a POI reduction technique will require. However, directional estimates may be obtained by using simpler estimates. For example, fans are required to move air to and from most control devices and are powered by motors that can consume large amounts of electricity. Other components such as powered dampers and valves and electronic/computer controllers consume electricity, but are generally small relative to motors. Many factors affect the efficiency with which motors consume electricity and detailed engineering is required for proper sizing and design. However, directional estimates can be made. Assuming 3 hp is required per 1000cfm of air moved and electricity costs about $0.08.KWH in Ontario, then the following calculation may provide a directional estimate of electricity required for many air pollution control devices ;

(airflow, cfm) x (operating hours) x 3 hp/1000 cfm x 0.746 kWh/hp x $0.08/kWh

It should be noted that 3hp/1000 cfm may seem high but the cost of running other electrical devices such as powered dampers and valves and electronic/computer controllers were not included. Other cost estimates could be made. The environmental professionals' judgment concerning potential electricity use is required to provide creditable cost estimates. It is important that the basis for the estimate(s) be clearly identified and recorded on the form using the space provided for comments and notes or by additional attachments if needed.

Potential electricity costs are automatically calculated on the three control device TRE forms based upon air flow (recorded at position D4) and operating hours (recorded at position H4). The assumptions and basis for the estimate are clearly recorded on the form(s).

Total Direct Annual Costs

The total direct cost is then the sum of items a. through f. and is automatically calculated by the form(s).

Indirect Annual Costs

There are additional recurring annual costs associated with bringing a POI reduction technique into operation and those costs are captured in as indirect costs. The items listed may provoke consideration regarding their relevance to the particular POI reduction technique being evaluated and provide a record of the environmental professionals' judgment concerning appropriate cost estimates. USEPA's OAQPS manual estimates these costs as fractions of labor costs and capital investment for control devices. These estimated values have been incorporated into the three control device TRE forms. It is important that the basis for the estimate(s) be clearly identified and recorded on the form using the space provided for comments and notes or by additional attachments if needed.

h. Overhead

Organizational overhead costs for operating labor and maintenance. These are the fixed facility operating costs that increase as the number of employees increase. Typical costs are estimated at about 60 percent of Direct Labor Costs according to USEPA's OAQPS manual and this factor has been incorporated into the three control device TRE forms.

i. Administrative Charges

This is an attempt to estimate overhead costs not specifically tied to facility operation such as sales, research and development, accounting, and other home office

expenses (not plant overhead). Typically these are estimated at 2 percent of the projects Total Capital Costs according to USEPA's OAQPS manual and this factor has been incorporated into the three control device TRE forms.

j. Property Taxes

Fixed assets are normally subject to property taxes. In Ontario, this value has been estimated at 1 percent of Total Capital Costs which is typically used as an approximation for directional projections.

k. Insurance

A simplified estimate for facility and equipment loss protection is obtained with a value of 1 percent of Total Capital Costs.

Total Annual O & M Costs (OMC)

Total Annual O & M Costs (OMC) is a sum of direct and indirect annual O & M costs (i.e. the sum of items a. through k.) and is automatically calculated by the form(s).

5.0 Total Annual Cost Savings (SAV)

Total Annual Cost Savings (SAV) is the sum of annual cost savings that may result from implementing a POI reduction technique. Efficiency projects can result in labor and utility reductions or material use savings. These costs should be identified and recorded and the overall cost of the proposal being evaluated reduced equivalently.

6.0 Total Annual Revenue (REV)

In some circumstances, a POI reduction technique may result in revenues for the facility. Total Annual Revenue (REV) is the value from the sale of residuals or by-

products and includes revenue increases due to productivity improvements resulting from implementing the POI reduction technique under consideration.

7.0 Total Annual Costs (TAC)

An estimate of the net total annual cost (NTAC) of purchasing, installing and operating equipment to obtain POI reduction may be obtained by summing the Capital Recover Cost, CRC (i.e. the capital cost spread-out evenly over a 10-year period at a 6% rate of investment return) and annual operating and maintenance cost (OMC) less any cost savings (SAV) and revenue (REV) identified.

$$NTAC = CRC + OMC - SAV - REV$$

Annualizing capital cost provides a convenient time frame for combining with operational and maintenance costs which are traditionally planned as yearly recurring expenses. Seasonal variations may also be normalized by using an annual period.

8.0 ESDM Information

The total annualized cost of a potential POI reduction technique is to be evaluated relative to a threshold risk reduction cost. Consistent with the Ministry's risk-based approach to evaluating alteration of air standard requests, the consequence of exposure to a contaminant(s) of concern should be considered in determining the threshold Risk Reduction Cost (RRC). The TRE methodology provides a means for comparing the TAC of a potential POI reduction technique to the RRC to derive a dimensionless value to advance the evaluation of the appropriateness of the action. Values needed to calculate a threshold RRC is largely determined based upon source information obtained from the facility's refined Emission Summary and Dispersion Model (ESDM) results. Additional information related to the potential reduction achievable by the source change and the consequence of exposure to the contaminant being evaluated complete the data needed to calculate a value. The following information is required.

a. Source Emission Before Change

It is important to establish a baseline condition for evaluating potential improvement options. The purpose of the TRE methodology is to evaluate the appropriateness of a POI reduction technique as it applies to an individual source and contaminant. The facility's ESDM will establish current source conditions resulting in the request for an altered air standard. This value is presented as an annual emission in units of tonnes and will be used to evaluate potential contaminant reduction options on an annual basis consistent with annualized cost estimates. A facility's ESDM will typically present emission rate (g/s) of each contaminant from each source. Maximum operating schedule for the source and unit conversions can be used to estimate annual tonnes emission of the contaminant. If the source does not have an operational restriction then 8,760 hours per year should be assumed. The calculated baseline emission of the contaminant in units of tonnes per year should be entered into the form(s) at position E61. Space is provided on the form(s) in the comments and notes columns to record assumptions used in determining the emission estimate.

b. Maximum POI Concentration

The facilities dispersion model will predict site-wide POI concentrations for each contaminant evaluated at an extensive grid of locations. For purposes of evaluating the potential site-wide improvement in POI concentrations attributed to the POI reduction technique, the location of the maximum POI concentration (C_{max}) must be established. The maximum POI concentration may be established for the overall site or the location of a sensitive receptor (i.e. residence, health care facility, child day care facility, senior citizens' facility, educational facility, etc.). The maximum POI concentration location should be used for the initial assessment. Other POI concentration may be used for purposes of a TRE evaluation but will require the concurrence of the Ministry. The maximum POI concentration value (ug/m^3) selected should be entered into the TRE form at position E62. The environmental professional should pay particular attention to clearly explain and record on the TRE form using comments, notes or attachments the basis for the maximum POI concentration value selected.

c. MOE Standard

The effects-based MOE standard for the contaminant for which the evaluation is being performed should be entered on the form at position E63. This value will be used to calculate the magnitude of exceedence by the facility to support estimation of the potential risk reduction achievable by the POI reduction technique being evaluated.

d. Frequency of Exceedence

The facilities dispersion model will predict the frequency with which the MOE standard would be exceeded based upon operating conditions and the meteorological data set utilized (Note: site specific approved meteorological data must be used to assess frequency of exceedences). The frequency value is expressed as a percentage and should be entered on the form(s) at position E64. Importantly, the environmental professional should make certain that the location of the frequency of exceedence value corresponds with the maximum POI concentration location selected and entered on the form at position E62. The frequency of exceedence (W_L) will always provide a mitigating factor relative to the magnitude of exceedence when evaluating the risk of exposure being addressed (i.e. the maximum POI concentration occurring 100 percent of the time represents higher risk than the maximum POI concentration occurring 1 percent of the time).

e. Consequence Score

A consequence score weight (W_{cs}) based upon the assignment of a contaminant to a category as defined in information presented in Appendix A to the Ministry's "Guide to Requesting an Alternative Air Standard" (GRAAS) (http://www.ene.gov.on.ca/publications/6322e.pdf) is entered on the form at position E65. The value will be either 1.43 (Major Health), 1.00 (Medium Health) or 0.86 (Minor Health or Environmental).

The consequence score is a dimensionless value that is used to scale the risk of exposure to a particular contaminant. Notably, exposure to some contaminants may have more significant consequences than others. The consequence scaling used in the TRE methodology builds off of risk management techniques presented in GIASO to establish a relative scaling of comparative 'effects' of different contaminants

related to health and the environment. Evaluation of a potential POI reduction technique must be assessed on an absolute scale to be of any value. Therefore, the GIASO consequence factors have been converted to an absolute scale for use in the TRE methodology.

Referring to GIASO Appendix II Table A-1: Consequence Categories Corresponding Weights (W_{cs}) (http://www.ene.gov.on.ca/envision/gp//5166e02.pdf), the relative scaled 'scores' are converted to absolute values by dividing each by the Medium Health score (7). Medium Health consequence represents the most significant (in terms of numbers) class of contaminants for which effects-based air quality standards have been developed. Assistance is provided in determining a contaminants primary 'effect' for purposes of standard development (i.e. Major Health, Medium Health, Minor Health, Major Environmental, Medium Environmental or Minor Environmental) in Appendix A to the Ministry's "Guide to Requesting an Alternative Air Standard" (GRAAS) (http://www.ene.gov.on.ca/publications/6322e.pdf). The 6 categories contained in GIASO Appendix II have been reduced to 3 categories for use in the TRE calculation; namely, Major Health (10/7 = 1.43), Medium Health (7/7 = 1.00) and Environmental and Minor Health (6/7 = 0.86).

f. Risk Quotient

The ratio of maximum POI concentration to the MOE standard is described as the risk quotient and is automatically calculated by the form based upon values entered in positions E62 and E63.

g. Risk Score

The risk score for the facility is calculated as the product of Risk Quotient (line f. value above, position E66 on form), Consequence score (line e. value, position E65) and frequency of exceedence (line d. value, position E64). The risk score value is automatically calculated by the form (position E67).

h. Potential POI Improvement

The environmental professional must estimate the POI reduction achievable by the option being evaluated. Add-on emission control device performance is often expressed as removal efficiency. However, other techniques for reducing contaminant emissions may also be expressed as percent improvements (i.e. material substitutions and process changes), in the technology evaluation stage. Estimating performance of a reduction technique may involve approximation of improvement by comparison to other similar sources. Estimation of reduction efficiency across a broad range of options is most easily expressed as a percent reduction.

Importantly, other source changes that could result in reduction of POI concentrations may be expressed by percent improvement. Source changes such as relocation of exhaust points within a facility can result in significant reduction to projected POI concentrations. While source relocation may not reduce contaminant emissions, its virtual effect may still be expressed as a percent reduction.

The environmental professional should make certain that the POI improvement potential is source specific and not associated with overall site improvement. The improvement percentage is related to the baseline emission established for the source in line a. (or position E61). Consequently, if the improvement technique being evaluated does not result in emission reduction (i.e. a source relocation), then, the contribution of the subject source to the maximum POI concentration is estimated before and after implementing the change. The estimated percent improvement for the source attributed to (or caused by) the evaluated reduction technique is entered in the TRE form at position E68. It is important that the assumptions and basis for the POI improvement percentage be clearly recorded in the space provided on the form(s) using comments, notes or attachments.

i. Equivalent Emission Reduction (or % POI Reduction)

The contaminant reduction potential for the option being evaluated is calculated by multiplying the source emissions before the change (line a., position E61) and the potential POI improvement (line h., position E68). This may represent an absolute source emission reduction or a virtual reduction (i.e. a POI improvement resulting from source location change) and is expressed in units of tonnes improvement per year. The value is automatically calculated by the form and entered at line i.

(position E69 on the form) and is used to establish the magnitude of the threshold risk reduction cost.

9.0 Threshold Risk Reduction Cost (RRC)

A threshold of annualized risk reduction cost is expressed as the product of site specific risk score (line g., position E67), site specific contaminant reduction potential (line i., position E69) and a cost factor. The cost factor used is $10,000 per tonne, which is adjusted upward or downward based upon consequence of potential exposure as expressed by the risk score. The formula is expressed as:

RRC = Risk Score * Potential POI reduction (tonne) * $10,000/tonne

The value is calculated automatically by the form (position E70) and represents the denominator in the ratio of Total Resource Effectiveness.

10.0 Total Resource Effectiveness (TRE) Value

The Total Resource Effectiveness Value is determined by the ratio of Net Total Annualized Cost (NTAC) for a potentially feasible POI reduction option to the threshold Risk Reduction Cost (RRC) derived to express the consequence of exposure to a contaminant considering site specific conditions.

The TRE values provide an indication of the relative effectiveness of potential POI reduction techniques. TRE values less than 1.0 would generally indicate a reasonably effective use of resources to achieve the POI improvement. However, TRE values above 1.0 and ranging up to about 10.0 may suggest further consideration is appropriate and/or refinement of assumptions are required. TRE values over 10.0 would generally indicate the potential POI reduction technique is not a good use of resources and perhaps other options should be considered.

Attachment 1 – Four (4) Calculation Forms


TRE Calculation Form for Fabric Filters.xls


TRE Calculation Form General.xls


TRE Calculation Form for Thermal Oxidizers


TRE Calculation Form for Venturi Scrubbers