Colorado Department of Public Health and Environment

SCREEN3 Stationary Source Modeling Guidance

January 1, 2002 (updated 12/28/05) Air Pollution Control Division / Technical Services Program

1. Introduction

Although the U.S. EPA's SCREEN3 air quality model may be used for several purposes, the guidance in this document is primarily intended to support screening-level air quality modeling analyses (compliance demonstrations) for Colorado and National Ambient Air Quality Standards (CAAQS and NAAQS). While this guidance is particularly intended for anyone conducting screening-level modeling for new minor sources or minor modifications, it could be applicable in some major source permitting situations. Permit applicants for new major sources or major modifications should refer to the *Colorado Modeling Guideline* and applicable regulations for additional modeling and/or analysis requirements.

For general modeling guidance and procedures, refer to the U.S. EPA's *Guideline on Air Quality Models* (Appendix W of 40 CFR Part 51) and the *Colorado Modeling Guideline*.

SCREEN3 (zip file) is the recommended tool to calculate screening-level impact estimates for stationary sources. For help using the model, refer to the SCREEN3 Model User's Guide (EPA-454/B-95-004) and the related U.S. EPA guidance document: "Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised" (EPA-454/R-92-019); available at: http://www.epa.gov/scram001/guidance_permit.htm.

In addition to the documents cited above, the U.S. EPA modeling clearinghouse contains documents and memos that help clarify U.S. EPA's guidance. U.S. EPA also has useful tutorials for some models. Although the SCREEN tutorial (zip file) is for the older SCREEN2 model, it is still helpful.

This is only a guidance document. It has been published in accordance with §25-6.5-102, C.R.S. It does not have the force and effect of a rule and is not intended to supersede statutory/regulatory requirements or recommendations of the U.S. EPA. U.S. EPA models and guidance are available on the Internet at: http://www.epa.gov/scram001.

2. Model Applicability

SCREEN3 is a single source model. It is not a multi-source model. Nevertheless, the impacts from multiple SCREEN3 model runs can be summed to conservatively estimate the impact from several sources. Section 2.2 – Merged Parameters for Multiple Stacks – in the U.S. EPA screening procedures document provides a method for modeling several sources that emit the same pollutant from several stacks with similar parameters. Nevertheless, in some situations, the source configuration or setting may be too complex to model with a simple tool like SCREEN3. Thus, it is not always possible to model a source with SCREEN3. In some cases, a refined model like ISCST3 should be used.

3. Concentration Estimates from SCREEN3

In simple terrain areas, SCREEN3 calculates 1-hour concentration estimates. Before comparing the modeled impact to the modeling significance levels or ambient air quality standards, the 1-hour concentration estimates should be converted to the averaging period of each applicable standards. In complex terrain, the model provides 24-hour concentration values. For more about converting concentration values from one averaging period to another, see section 11.

4. General Procedures for Compliance Demonstrations with Ambient Air Quality Standards

If a modeling analysis is warranted (see section 2 of the *Colorado Modeling Guideline*), the Division usually recommends that a *significant impact analysis* be conducted to help determine the scope of the modeling analysis.

If the estimated impact from the new source or modification is above the modeling significance levels in ***Table 1***, a compliance demonstration with the Colorado and National Ambient Air Quality Standards (CAAQS and NAAQS) is triggered. If the impact is below, the impact is considered to be insignificant and further air quality analysis is not usually warranted (i.e., it is not necessary to add a background concentration or to determine if there are any nearby sources that should be accounted for in the analysis).

Table 1. Modeling significance levels to determine if a source will have a significant impact on ambient air quality standards.

Pollutant	Averaging Period				
	Annual	24-hr	8-hr	3-hr	1-hr
Carbon Monoxide (CO)	a	a	500μg/m^3	a	2,000μg/m^3
Nitrogen Dioxide (NO_2)	1 μg/m^3	a	a	a	a
Sulfur Dioxide ($SO_{2)}$	1 μg/m^3	5 μg/m^3	a	25 μg/m^3	a
Particulate Matter <10 μm (PM-10)	1 μg/m^3	5 μg/m^3	a	a	a

a A modeling significance level has not been defined for this averaging period.

A compliance demonstration with standards is sometimes referred to as the *full impact analysis* or the *cumulative impact analysis*. A full or cumulative *air quality impact analysis* involves a more comprehensive assessment of air quality impacts. It is discussed in section 4 of the *Colorado Modeling Guideline*.

If the impact from the new source or modification is significant and a CAAQS and NAAQS modeling analysis is warranted, use the procedures in Section 4.1 of the *Colorado Modeling Guideline*. In addition, refer to section 4.5.6 in EPA's "Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised" for additional recommendations about screening-level modeling in multi-source areas.

The overall impact estimate in a compliance demonstration should account for the source under review plus existing air pollution levels at the locations (receptors) where the source has a significant impact. This can be done in several ways. In general, the compliance demonstration for standards should include:

1) the estimated (i.e., modeled) impact for the new source or modification (see section 4.1.3 in the *Colorado Modeling Guideline*);

2) an estimate of existing air quality levels within the probably area of influence of the new source or modification; at a minimum, a monitored background concentration is used (see section 4.1.5 in the *Colorado Modeling Guideline*). In some cases, there may be existing refined modeling in the area or at the source under review. If so, the historic modeling results can sometimes be used to account for existing sources at the facility and/or nearby sources. In some cases, it is necessary to model additional sources, such as:

   (a) existing sources at the facility under review (see section 4.1.4 in the *Colorado Modeling Guideline*);

(b) existing ***nearby*** and ***other background*** sources (see section 4.1.4 in the *Colorado Modeling Guideline*);

(c) proposed nearby sources (this includes those which have received PSD permits but are not yet in operation and others that have submitted *complete* PSD applications to a reviewing agency, but have not yet been issued permits; it may also include any large new ***minor sources*** that have received permits, but are not yet in operation).

5. Emission Rates

For the source under review (and for nearby sources), the emission rates used in the CAAQS and NAAQS compliance demonstration modeling should be based on federally enforceable emission limits, design capacity, controlled potential-to-emit, or similar allowable emission rates. This is a federal requirement in Appendix W of 40 CFR Part 51. For a more detailed explanation, see secions 4.1.3 and 4.1.4 in the *Colorado Modeling Guideline*.

While the emission rates entered into SCREEN3 are in units of grams per second, the emission rate entered into the model may be varied depending on the averaging period of interest. The emission rate entered into SCREEN3 should represent the maximum allowable emission rate allowed under the permit for the applicable averaging period. If there are no short-term emission limits, the modeled emission rate should reflect the design capacity or controlled potential-to-emit.

The usual procedure is to model the allowable short-term emission rate to determine if the source will comply with short-term (≤ 24-hours) and long-term (annual) standards. If compliance is shown with both standards, the analysis is complete; however, if compliance is not shown with the long-term standard, for example, the gram per second emission rate in SCREEN3 may be changed to reflect the allowable long-term emission rate.

6. Receptors

For SCREEN3 modeling, the receptor grid should be designed to locate the maximum concentration (see section 2.4.5 in the "SCREEN3 Model User's Guide"). When appropriate, the APCD recommends using the "automated distance array option" so that the model's iteration routine can locate the maximum value. For example, place the first receptor distance at the nearest fence line distance from the source (e.g., 10 meters); place the second receptor distance at a sufficiently large distance to find the maximum (e.g., 10,000 meters).

It is usually recommended that the receptor height be set to 0 meters (e.g., ground-level). Flagpole receptors (e.g., receptors located above ground-level) should be considered only in situations where there may be exposure concerns above ground-level. For example, if there

is reason to believe the plume will impact a nearby apartment balcony, it might be appropriate to use flagpole receptors.

For the compliance demonstration, only those receptors in ambient air (i.e., receptors at or beyond the fence line or other physical barrier that prevents access by the public) need to be considered.

Refer to the secton 6.3 of the *Colorado Modeling Guideline* for additional guidance on receptor networks.

7. Building Downwash

If a stack is within a buildings “area of influence” (e.g., a distance of five times the lesser of the building’s height or maximum projected width), the stack might be influenced by the wake of the building. If so, it’s necessary to obtain or estimate building dimensions (e.g., height, width, and length) to run SCREEN3. Sources subject to aerodynamic turbulence induced by nearby buildings and structures should use the building downwash options in SCREEN3**.** Refer to EPA's SCREEN2 tutorial for example modeling exercises for sources with building downwash. As discussed in section 9, it is not necessary to enter terrain elevations when the building downwash options are used in SCREEN3.

8. Selection of Meteorology

In general, follow the recommendations in the SCREEN3 Model User's Guide and use the "full meteorology" option. The exception to this is for sources that have or will have operating schedule restrictions. For example, if a sand and gravel plant only operates from 8am to 5pm and there are or will be permit conditions restricting operation to these hours, then SCREEN3 may be run by stability class. That is, run SCREEN3 with A, B, C, and D stability classes, but exclude those classes (E and F) that occur only at night.

9. Complex Terrain

Sources located in complex terrain (terrain above release height) should consider using the terrain options in SCREEN3 to estimate impacts on nearby elevated terrain; however, if it is expected that the maximum impact will be controlled by building downwash and not by nearby terrain, it may not be necessary to use the terrain options in SCREEN3.

Refer to EPA's SCREEN tutorial for example modeling exercises for sources in complex terrain. Terrain elevations near the source may be obtained from 7.5 minute USGS topographic maps in hardcopy form or as Digital Raster Graphics (DRG) images. Digital Elevation Model (DEM) data may also be used to determine elevations. Refer to the

Colorado Modeling Guideline for additional discussion regarding elevation data for receptors.

The complex terrain algorithms in SCREEN3 are for point sources, not area sources. Thus, it is not necessary to use the complex terrain options in SCREEN3 for area source modeling. In addition, the complex terrain algorithms in SCREEN3 are for elevated plumes. It should also be emphasized that SCREEN3 "will not consider building downwash effects in either the VALLEY or the simple terrain component of the complex terrain screening procedure, even if the building downwash option is selected." (ref: "SCREEN3 Model User's Guide"). Thus, if impact estimates are appropriate for both complex terrain and building downwash scenarios, two separate SCREEN3 runs must be performed; one for complex terrain and one for building downwash.

As stated in the SCREEN3 tutorial, SCREEN3 generates a message indicating the final stable plume height, the distance to final rise, and instructions on how to select complex terrain locations for modeling in order to identify the worst-case impacts. The worst impact will generally occur at the nearest location where the stable plume actually impacts on the terrain. This is found by locating the nearest location where the terrain elevation is at or above the final plume height. For terrain locations closer than the distance to final rise, the plume may impact on the terrain at a lower elevation.

10. Conversion of NO_x to NO_2

When modeling NOx emissions from combustion sources, the estimated NOx concentration may be multiplied by 0.75 to obtain the nitrogen dioxide (NO_2) concentration.[1] The other methods allowed under federal rules are generally intended for refined-level modeling, not screening-level modeling. Thus, if use of the 0.75 ratio is not sufficient to show compliance with standards, it is usually recommended that a refined-level model be used.

[1] Most of the NOx emissions from combustion sources are emitted in the form of nitric oxide (NO), not nitrogen dioxide (NO_2). While some of the NO is converted to NO_2 by thermal reactions caused by the relatively high temperatures during the combustion process, it is usually assumed that about 90% of the NOx is emitted to the atmosphere as NO where it can be transformed into NO_2. When the NO plume mixes with ambient air, atmospheric chemical reactions occur. For example, NO reacts with ozone (O_3) to form NO_2. This is usually the primary mechanism for converting NO to NO_2 in rural areas. In urban areas, other reactions such as those with hydrocarbon oxidation products (e.g., hydroperoxyl (HO_2) and alkyl peroxy (RO_2) free radicals) can be important. The U.S. EPA recommends using a national default NO_2:NOx ratio of 0.75 (as calculated using the Ambient Ratio Method (Chu, S. and Meyer, E. L. *Use of Ambient Ratios to Estimate Impact of NOx Sources on Annual NOx Concentration.* Air & Waster Management Association, June 1991)) to estimate how much of the estimated NOx concentration exists as NO_2 in ambient air. The Division has reviewed the ratio in Colorado and believes it provides a conservative estimation (overestimation) of actual NO_2 impacts from stationary sources of NOx in Colorado. Thus, it is reasonable to use in screening-level modeling analyses.

11. Multiplying Factors

The SCREEN3 model generates 1-hour concentration estimates (unless the complex terrain mode is being used, in which case it also generates a 24-hour estimate). Initially, the 1-hour average estimates may be compared directly to ambient air standards. If compliance is NOT shown for a given averaging period, the 1-hour averages may be converted to a longer averaging period using the guidance below.

POINT SOURCES AND FLARES

For "points" and "flares," use the U.S. EPA multiplying factors shown in Table 2 to convert 1-hour concentration estimates from SCREEN3 to other averaging periods.

Table 2. "POINT" source multiplying factors to convert 1-hour average concentration estimates from the SCREEN3 model to longer averaging periods.

Averaging Period	EPA Multiplying Factor for POINT Sources[a]
3 hours	0.9
8 hours	0.7
24 hours	0.4
annual	0.08

[a] "Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised," EPA-454/R-92-019, page 4-16).

VOLUME SOURCES

EPA has not developed multiplying factors for "volume" sources. Follow the recommendations in the first paragraph under "AREA SOURCES."

AREA SOURCES

EPA has not developed multiplying factors for "area" sources. For fugitive sources modeled with the "area" source algorithm in SCREEN3, EPA guidance recommends that the maximum 1-hour concentration be conservatively assumed to apply to averaging periods out to 24-hours. In many cases, it's reasonable to assume that the compliance demonstration for the 24-hour NAAQS is protective of the annual NAAQS; but there

may be situations where this assumption is not valid. Thus, professional judgement must be used to decide if this assumption is valid. If compliance with the annual PM standard is believed to be issue (e.g., if there is a high annual background concentration), then refined modeling (e.g., ISC3) may be necessary.

The APCD realizes that, in most cases, it is very conservative to assume that 1-hour average concentration estimates are the same as 24-hour estimates. This is particularly true for sources where mechanical turbulence is important (e.g., haul roads). Thus, the APCD has developed 24-hour and annual multiplying factors for "area" sources that operate only during daytime hours (e.g., 7am to 5pm). The APCD has not yet developed such factors for sources that operate 24-hours per day.

The Colorado multiplying factors in *Table 3* may be used provided that the criteria in the table's footnotes are met. These multiplying factors are based on ISCST3 runs using Denver Stapleton Airport and Pueblo Airport meteorological data.

Table 3 "AREA" source multiplying factors to convert 1-hour average concentration estimates from the SCREEN3 model to longer averaging periods.

Averaging Period	Colorado Multiplying Factor for AREA Sources[a]
24 hours	0.15
annual	0.03

a The "area" source must meet the following criteria for these factors to be valid:

1. Sources modeled as "area" sources must have a significant degree of mechanically generated turbulence (e.g., sand and gravel operations, haul roads).
2. The facility must operate only during the daytime (e.g., 7am to 5pm).
3. The factors are NOT intended for new sources or modifications subject to PSD rules.

12. Modeling Methodology for "Fugitive" Particulate Matter Sources

Professional judgement must be used on a case-by-case basis to decide which sources at a facility should be modeled as "area" sources. For example, if the facility consists of an elevated point source (e.g., 10 meter tall stack) for which stack parameters can be estimated, haul roads, wind erosion, and near-ground-level quarrying activities, it would be appropriate to run the SCREEN3 model twice. The first SCREEN3 run would model emissions from the elevated point source as a "point" source. The second run would model the "fugitive" sources as an "area" source using the procedure below. Initially the maximum impact from each run of SCREEN3 could be added to calculate the cumulative impact. If this fails to show compliance, the estimates from each run may be superimposed (i.e., add concentration estimates on a receptor-by-receptor basis).

The following screening procedure is ***applicable for modeling fugitive sources of particulate matter*** (e.g., near-ground-level sources at sand and gravel plants):

1. ***Model the maximum daily and annual emission rates.***[2] The controlled potential-to-emit (design capacity) should be modeled unless the applicant is willing to accept lower emission rates as permit conditions. The short-term emission rate should reflect activities that are allowed to occur during a maximum production day. If there are several different emission scenarios of concern and it's not obvious which would be controlling, it may be appropriate to perform several SCREEN3 runs that look at different operating scenarios

2. Using professional judgement***, determine the dimensions of one or more SCREEN3 area sources*** to represent the regions where emissions occur. In most cases, it is acceptable to use a single ***area*** source. For example, it may be reasonable to base the dimensions of the ***area*** source on the total disturbed area for a daily or annual period, as appropriate. The total disturbed area for annual NAAQS modeling may be larger than the area used for short-term NAAQS modeling when appropriate.

3. Divide the total emission rate (in units of grams per second) by the area (in units of m^2) of the "area source" to ***calculate the emission rate in units of grams per second per meter squared***.

[2] Use the maximum "daily" production rate for short-term NAAQS modeling (e.g., 24hr PM10 NAAQS), if available. Use the "annual" production rate for annual NAAQS modeling.

4. ***Assume a release height of 10 meters in SCREEN3***.[3] This release height is intended to account for mechanical turbulence, the presence of on-site berms or pits, and similar factors that influence the dispersion of particulate matter from "fugitive" sources.

5. ***Use the "full meteorology" option*** in SCREEN3.

6. ***Assume simple terrain***.

7. ***Use 100 meter or finer receptor spacing out to a distance of at least 1000 meters*** (i.e., make sure the maximum impact is included in the receptor network). It is recommended that the "automated distance array option" in SCREEN3 be used. [NOTE: Remember that the receptor distances in SCREEN3 are measured from the ***center*** of the rectangular area, not from the edge. This may be important in determining which receptors are located in "ambient air."]

8. ***Refer to the section on "MULTIPLYING FACTORS"*** for recommendations on how to convert 1-hour SCREEN3 estimates to the longer averaging times.

9. ***Add a suitable background concentration*** to account for "nearby" and "other" background sources. Be sure to also include the concentration estimates from any other runs of SCREEN3 that were performed for other sources at or near the facility.

10. ***If the cumulative impact fails to show compliance with ambient air standards, refinements to the SCREEN3 modeling may be possible***, for example:

    - If the facility operates only during the day, the modeling can be redone using PG Stability Classes A, B, C, D (i.e., separate runs of SCREEN3 using PG classes 1, 2, 3, and 4). That is, exclude stable conditions (E and F) that can only occur at night. This normally results in lower estimates. This is ONLY acceptable for sources that do not operate at night.
    - It may also be helpful to revisit the emission rate(s) used in SCREEN3 to make sure that the modeled emission rates reflect activities that could realistically occur during a maximum production day.

[3] The use of a 10 meter release height for "area" sources is allowed without justification ONLY for SCREEN3 modeling using the procedure above. It is NOT a general recommendation for all SCREEN3 modeling or for refined (e.g., ISC3) modeling. That is, the APCD generally recommends that release heights should be determined and justified on a case-by-case basis. The 10 meter release height recommended in the procedure above was determined by comparing estimates from refined ISC3 runs (with variable release heights for haul roads and similar near-ground-level sources) to results from SCREEN3 runs at various release heights. The comparison found that use of a 10 meter release height in SCREEN3 estimated impacts similar to, but more conservative than ISC3 runs where release heights had been determined on a source-by-source basis (e.g., hauls roads were modeled as volume sources with a release height of 2 meters and a sigma-z of 3 meters).