Preliminary Comments from Members of the CASAC Sulfur Oxides Panel on
EPA’s Review of the Primary National Ambient Air Quality Standard
for Sulfur Oxides:
Risk and Exposure Assessment Planning Document
(External Review Draft – February 2017)
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Analytical Approach and Study Area Selection:

2. The criteria identified and approach used to select potential study areas to evaluate for this REA. [Section 4.1.2]

The four candidate study areas are reasonable as they meet the criteria for air quality data, design values, and population size. The four areas include different SO2 sources (e.g., steel mill in Cuyahoga County, OH, lead smelting in Marion County, IN, pulp and paper in Brown County, WI, and a fertilizer plant in Hillsborough County, FL) in addition to electric generating units (EGUs). However, three of these areas are close to water bodies (with the exception of inland Marion County, IN). The selection does not cover all relevant geographical regions (i.e., Midwest, Northeast, South, and West) defined by the National Health Interview Survey (NHIS, Page 4-26). Complex terrain features (e.g., plume impact on elevated terrain) are ignored. Sites near the ocean or a lake may experience additional moisture resulting in enhanced SO2 to sulfate transformation and therefore may not represent typical SO2 exposure.

Although large SO2 sources (>100 tons per year) are shown in Figures 4-2 to 4-5 (Pages 4-8 to 4-11), the range of emissions from 4,821 to 142,920 tons per year spans more than two orders of magnitude. It would be helpful to provide the most recent (e.g., 2013 to 2015) statistical summary of 5-minute hourly and daily 1-hour maximum values, as well as hourly and daily average values, for the selected areas. With a design value of 65 to 85 ppb in these four areas, the number of days that 5-minute maximum values exceeded 100, 200, 300, and 400 ppb benchmark concentrations should be given. Figure B-1 of Appendix B shows that nationwide, there are 30 to 90 days with SO2 concentrations exceeding 125 ppb. Perspective should be given with respect to the exposure-response of these elevated SO2 concentrations.

Detailed national statistics are given in the second draft SOx ISA (U.S. EPA, 2016a) for six focus areas during the 2013 to 2015 period. Other than four sites in Ohio included in both the Cleveland-Elyria-Mentor and Cuyahoga County study areas, none of the focus areas (i.e., Gila County, AZ, St. Louis, MO-IL, Houston-Sugar Land-Baytown, TX, Pittsburgh, PA, and New York-Northern New Jersey-Long Island, NY-NJ-PA) correspond to the selected REA modeling areas. The EPA may want to consider including some of the ISA focus areas (especially those like Gila County, AZ) in the West with high copper smelting emissions (>21,747 tons/year) and elevated (282 ppb) 5-minute hourly maximum SO2 concentrations (see Figure 2-18, Page 2-43 of the second draft SOx ISA).
Ambient Air Concentrations:

1. The use of an AERMOD model-based approach to predict hourly concentrations at all receptor locations within selected study areas. [Sections 3.3.2, 4.1.1, 4.1.4]

It is encouraging that the EPA has made several updates to the AERMOD modeling system and its data processors such as AERMET, AIRMINUTE, and AERMAP (U.S. EPA, 2016b). With the improvement in terrain and meteorological processors, better agreement should be found in hourly SO2 concentrations between AERMOD model predictions and ambient SO2 measurements. Sensitivity tests need to be conducted with the new options for adjustment of surface friction velocity under 1-minute low wind speed and building downwash to demonstrate the improvements in AERMOD model simulation and exposure assessment. Performing preliminary model runs of surrounding sources to determine the spatial scale that best captures concentration gradients seems reasonable. Since AERMOD is a Gaussian plume model that does not account for plume looping and short-term touchdowns, an hourly average is a minimum averaging time.

2. The use of SO2 measurements at ambient air monitors within and near the study areas to estimate continuous 5-minute concentrations, where appropriate (e.g., filling missing values, for AERMOD hourly predictions). [Sections 3.3.1, 4.1.4]

Although the number of monitors reporting 5-minute concentrations has increased since 2011 (Figure 3-1, Page 3-6), it is unfortunate that only ~40% of monitors in the compliance network report 12 consecutive 5-minute measurements for each hour (Page 3-5). A great deal of effort has been made (Section 4.1.3.2) to estimate the unreported 5-minute concentrations where only the hourly maximum 5-minute concentrations are reported.

The approach to estimate the other eleven 5-minute measurements seems reasonable. However, the progressive decrease in SO2 concentrations in Tables 4-3 and 4-4 (Page 4-16 and 4-17) does not necessarily reflect the frequency and duration of plume touchdown and downwash mixing, adding uncertainties to the modeling results.

Federal Reference Method (FRM) instruments for SO2 are capable of producing short-duration averages; consistent reporting of each 5-minute average by the states is preferred. This would allow for the examination of consecutive elevated 5-minute SO2 concentrations and a clearer understanding of the exposure durations and diurnal variations. The EPA is encouraged to require states to report each 5-minute average, as it will provide a database to evaluate a future 5-minute SO2 NAAQS indicator.
3. The proportional approach selected for adjusting ambient concentrations to simulate air quality that just meets the existing standard.

[Section 4.1.3.4]

As the highest design value (DV) is used to derive a single multiplicative factor ($F$) to adjust the monitored concentrations across the study area, the selection of an appropriate DV is important. The REA asserts that the adjustment for ambient concentrations used in the exposure assessment is likely to be small (<10%, Page 4-20), inconsistent with the large variations in DV values (from 78 to 92 ppb in Marion County, IN and 66 to 93 ppb in Tampa, Hillsborough County, FL over the 2011 to 2013, 2012 to 2014, and 2013 to 2015 periods) shown in Table 4-1 (Page 4-7). The representativeness of DVs needs to be clarified.

References


Dr. Delbert Eatough

I was specifically asked to focus on Ambient Air Concentrations. However, as I read the document my areas of concern centered on both the material on Analytic Approach and Study Area Selection (Section 4.1.2) and Ambient Air Concentrations (Section 4.1.3). My comments will address both of those areas. I will focus on how decisions in the structure of these two sections effect the development of the “Exposure Modeling (Apex)” purple box and subsequent development of the “Lung Function Exposure-Response Function Relationship” red box in the Figure 4-1 (page 4-2) Overview of the analysis approach for the REA. In particular, I will comment how decisions made on the Study Area Selection (Section 4.1.2) may well lead to the underprediction of response.

Background on Areas of the ISA and REA which contribute to my concerns.

In my written comments on the ISA I pointed out that CASAC had requested the following of EPA in the development of the Second Draft ISA:

In the April 15, 2016 letter to Administrator McCarthy we stated,

“The CASAC finds that the source categories and definitions of major sources are inconsistent throughout Chapter 2 as well as the entire ISA and recommends that these be consistent. The chapter should include locations and emissions for point sources (energy-generating units, integrated steel and iron mills and smelters) near urban centers.”

In the 03/10/16 Draft Report we further stated,

“The importance of pollution sources and formation of non-sulfate compounds such as inorganic particulate S(IV) species, organic S(IV) species (e.g., bis-hydroxy dimethyl sulfone) and organic S(VI) species (e.g., alkyl sulfates) requires additional discussion. Studies such as Alarie et al. (1973) and Amdur (1971) demonstrated the relationship between exposure to inorganic S(IV) compounds and exacerbation of SO2 inhalation responses in animals. These compounds are potential confounders or moderators of SO2 health effects in epidemiological studies where copper smelter or integrated steel mill emissions are abundant and the possible influence of these compounds should be discussed.”

And in my Final Comments on Draft IRP I outlined in detail what was known about the above outlined chemistry and recommended,

“Probably a more fruitful set of data to evaluate the relative importance of aerosol S(IV) species associated with smelter emissions would involve past epidemiological studies from about two to
three decades ago when smelter emission were much more significant, for example from the TX
smelters in El Paseo (ASARCO Cu smelter, closed in 1999), and Corpus Christi (ASARCO Pb
smelter, closed in 1985), AZ smelters (ASARCO Cu smelter in Hayden, currently operating and
Phelps Dodge Cu smelter in Douglas, closed in 1987), from the Kennecott Cu smelter in Magna,
UT prior to construction of the tall stack, from the Tacoma WA smelter (American Smelting and
Refining, a Cu smelter specializing in high As ore refining, closed in 1985), or the smelters in
Montana (ASARCO Pb smelter in East Helena, closed in 2001, Anaconda Cu smelter in
Anaconda, closed in 1981) and Idaho (Bunker Hill Pb smelter in Kellogg, closed in 1982). I
know that several epidemiological studies were conducted at these locations, but I am not
familiar with the results of these studies with respect to asthma exacerbation. I recommend that
EPA look at this older data to see if an estimate of the relative potency of SO2 and smelter
associated aerosol S(IV) species can be determined. There will not be data on the concentrations
of S(IV) in the aerosols emitted from these sources, so total particulate exposure would need to
be used as a surrogate. The importance of elucidating the effect of these exposures is correctly
alluded to in the ISA on Page 4-12, Line 11.”

My comments on the Second Draft ISA point out that these requests were not responded to in the
second draft ISA with the following two consequences:

1. It would appear from data in the ISA that the highest anthropogenic associated
concentrations to which a population is exposed under current SO2 emissions is
dominated by emissions from smelters and integrated iron and steel mills. Further, with
respect to current conditions, high exposure concentrations resulting from emissions from
EGUs is rare. I have asked in my comments on the ISA for additional information from
EPA in the ISA to make this point clearer.

2. The request to explore the hypothesis that the presence of particulate inorganic S(IV)
species in emissions from smelters and integrated iron and steel will result in a greater
exacerbation of asthma in exposed populations will result in higher risk than the exposure
to SO2 alone, such as you might see in emissions from an EGU was not considered by
EPA.

Consequence 1. means that the development of a Risk and Exposure Assessment document
which focuses on EGU emissions will underestimate the highest exposures which will lead to the
highest risk.

Consequence 2. Means that if the hypothesis is correct, the risk will be further underestimated by
not focusing on the higher emissions to which populations are exposed from living near a smelter
or an integrated iron or steel mill and which emissions are associated with a higher risk from
sulfur oxides than that due to only SO2.
Section 4.1.2 Exposure Domain

There are two statements in the material in Section 4 which precede 4.1.2 which appear to me to be contradictory and which directly affect the choice of Exposure Domains. On page 4-1 first paragraph the REA states “The objective for the REA for this review is to characterize exposure and health risk associated with SO2 from ambient air under conditions just meeting the current primary standard.” In Section 4.1, page 4-3 last paragraph the REA states “Additionally, as part of this analysis, the population-based statistical distribution of exposures will also be evaluated to identify important exposure environments and/or influential activities that lead to those estimated as having greatest potential health risk.” I would think the second point is more important than the first if the objective is to identify the risks which should guide decisions on whether the SO2 standard needs to be revised.

With these points in mind, let me comment on the four identified potential study areas in Section 4.1.2. and on the associated figure for that study area.

First a general comment on the four figures: Figures, 4-2 through 4-5 are quite confusing. The various sources shown are given in the Key as squares, but show in the figure as circles. It would also be very helpful if the sources were specifically identified and not only listed in Table 4-1 as to type and not as to size.

Brown County WI contains Green Bay. It is not one of the sites identified in Figure 2-11 of the second draft ISA as a site with the 99th percentile of 1-h daily max sulfur dioxide concentrations reported to be above 75 ppb. The data in Table 4-1 indicate the DV is just at 75 ppb. Impact appears to be from pulp and paper facilities, mostly near the single monitor in the Study area. It would help if the specific sources and emissions were given. I assume the EGU is the large source in the central circle. I further assume that it has a tall stack and will not significantly impact the single monitor in the study area. I would consider this study area (with only one monitor) to be less valuable than the FL study area.

Cuyahoga County OH contains Cleveland. It is one of the sites identified in Figure 2-11 of the draft ISA as a site with the 99th percentile of 1-h daily max sulfur dioxide concentrations reported to be above 75 ppb. The DV in Table 4-1 of the REA for this study area is 62. There are four monitors shown in the study area. The highest concentration for the four is for MONID 390350060. According to Figure 2-13 of the second draft ISA the 99th percentile of 5-minute hourly max sulfur dioxide concentration at that monitor during 2013-2015 was 61 ppb. Based on the data in Figure 2-13 of the second draft ISA I believe the emissions source to the right of the four monitors shown in Figure 4-3 is the 2133 tpy ArcelorMittal integrated iron and steel mill. The smaller emissions source in the middle of the four sampling stations in Figure 4-3 of the REA is not shown in the ISA. It would be useful to know what that source is. The advantage of this study area is the presence of four monitors to aid in the APEX analysis. It is possible that these four monitors are influenced by emissions from an integrated iron and steel mill. The
highest monitoring site in this area given in Figure 2-13 of the ISA is E, which averages 85.7 ppb. Both the monitor and the nearby emissions source are within the domain shown in Figure 4-3, but they are not shown. The nearby 2745 tpy emission source is not identified, but I have asked for that to be added to the draft ISA. The large red source in the middle of the upper circle for Figure 4-3 is not identified, but I am sure it is an EGU (with an adjacent Monitor with a 20 ppb average values not shown in Figure 4-3) given in Figure 2-13 of the ISA. Distance from Cleveland to ISA E is 30 mi. The monitor by the power plant is about midway between the two. Why are these two additional monitors (and site) near Cleveland not included in the study area? It does not seem wisdom to not include the monitor with the highest SO2 readings and a clear impact from a nearby source in the analysis. If all potential data were used, this could be a very viable study area. It further has the advantage that it would look at the probable impact from an integrated steel mill. I would surely also like to know that the emission source near Painesville is. If it is the Painesville Electric Plant (which does not appear to have a tall stack) it would be a unique opportunity to include the impact of an EGU in the study area analysis.

Hillsborough County, FL contains Tampa. It is not one of the sites identified in Figure 2-11 of the draft ISA as a site with the 99th percentile of 1-h daily max sulfur dioxide concentrations reported to be above 75 ppb. The DV in Table 4-1 of the REA for this study area has dropped over the years and is currently 66. Table 4-1 indicates there is only 1 monitor to be included in the analysis for the study area and sources are Fertilizer Plants and an EGU. However, there are five monitoring sites shown in Figure 4-4. Why are the other monitoring sites not being included in the APEX analysis? This would surely increase the power of the analysis. I assume the red circle (the key looks like it should be a square) centered on the bottom blue circle is the EGU. I also assume it has a tall stack and will not have a major impact in the study area. What, specifically is the source vert near to the MONID 120570109 monitoring site. How probable is it that, even if it has emissions less than 1136 tpy, it will impact the site. Do the data from the nearby monitor suggest this will be the case? I consider this a reasonable study area if all monitoring site data are included in the analysis.

Marion County IN contains Indianapolis. It is not one of the sites identified in Figure 2-11 of the draft ISA as a site with the 99th percentile of 1-h daily max sulfur dioxide concentrations reported to be above 75 ppb. The "lead smelter" listed in Table 4-1 for Marion County IN is the RSR-Quemetco Battery Recycling Facility on the west side of Indianapolis (identified as yellow and directly west of the monitoring site MONID 180970057) and is not a smelter. There is only one monitor in the study area and it has a DV 79. There are two other monitoring stations identified but the key indicates they have no valid data. I would consider this site (with only one monitor) to be less valuable than the FL site.

Your choice of sites is skewed towards lower concentrations and generally avoids emissions from smelters and integrated steel mills. Because of the general use of tall stacks, EGU emissions will be low at all sites, with the possible exception of Cuyahoga County if the study area were enlarged as suggested in my comments. I suggest you at consider dropping both the
proposed WI and IN study areas to give additional areas with multiple monitors and, ideally, increased attention to emissions from integrated iron and steel mills and smelters.

I suggest you consider including the Detroit, Wayne Co, MI study area. It would be useful to have a map of that study area like Figures 4-2 through 4-5 to further evaluate that possibility. If the data from the multiple monitors (6) in this potential study area could all be used in the APEX analysis this would be a strong point for including Detroit as a study area. In addition, if the possibility of looking at the impact of emissions from the Zug island steel mill or the Trenton Channel Power Plant located near the steel mill or the closely located together DTE Belle River Power Plant and St. Clair Power Plant in the northeast part of Detroit existed this would further indicate it would be an excellent study area. The three mentioned EGUs do not have tall stacks and they may contribute to more local impacts. The last point could be determined by examination of the data from the six monitors in Detroit.

I suggest you also consider adding Gila County (Figure 2-18 of the second ISA draft) as a study area. I recognize that it does not include the population minimum of 100,000 you listed in your criteria for a study area (current county population, 53,000). However, it does contain four monitoring site, each of which have 99th percentile 5-minute max concentration above 100 ppb during 2012 – 2015 (Figure 2-18, second ISA draft). It is the only place where exposure of a population to emissions from smelters can be modeled. As summarized in my comments on the ISA and my discussion at the start of these comments, EPA has been charged by CASAC to consider the effect of exposure to particulate inorganic S(IV) compounds in emissions from smelters as “These compounds are potential confounders or moderators of SO2 health effects in epidemiological studies where copper smelter or integrated steel mill emissions are abundant and the possible influence of these compounds should be discussed.”

If EPA responds to the request to explore the hypothesis that these compounds are confounders of exposure to SO2 alone and that the effect of the exposure to both is to increase the exacerbation of asthma, then failing to consider smelter emission in the REA analysis will lead to an underestimation of the Lung Function Exposure – Response Relationship and the Ling Function Risk (Figure 4-1). Of course, if EPA does not explore the hypotheses and the hypothesis is correct, the health effects of exposure of asthmatics to SO2 will still be underestimated by EPA as decisions on the future form of the standard are made. This will be true no matter how well the modeling exercise described in Section 4.1.3 is conducted.

Section 4.1.3 SO2 Concentrations in Ambient Air

Section 4.1.3.2, page 4-13. Second paragraph. It is not clear to me that the assumption that “where ambient air measurements are missing likely occur at times where concentrations are relatively low, thereby yielding slightly lower means and standard deviations when comparing substituted data relative to the unsubstituted data” is valid. It seems to me that missing data are
due to a monitor problem and not an ambient air concentration condition. What will be the effect if this assumption is not valid and the missing data are high?

I feel uncomfortable with Equations (4-1), (4-2) and (4-3). It seems to me that an important feature of the analysis should be the use of multiple monitors and a study area to predict exposure using AERMOD and APEX. How can 5-minute data from multiple monitors have any comparison value if estimated as outlined. Are we limited to hourly average modeling for sensible results? I will let modelers in the group comment on this.
Dr. Farla Kaufman

Health Risk Assessment:

1. **The general structure and overall approach that staff plans to use for the risk assessment.** [Section 4.2]

   The general structure and overall approach as outlined in section 4.2 of the planning document seem appropriate and clearly laid out.

2. **The approaches for using findings from the controlled human exposure studies.**
   
   a. **The health benchmarks identified for this REA.** [Sections 3.2.2, 4.2.3]

   Generally the approaches for using findings from the controlled human exposure studies with regard to identifying health benchmarks seem appropriate. However, I would add the following caveat.

   The REA states there is no evidence to indicate that individuals with severe asthma “would experience moderate or greater lung function decrements at lower SO2 exposure concentrations than individuals with moderate asthma”. However, based on the available data there is not sufficient evidence to the contrary. As noted in the REA individuals with severe asthma are not generally represented in the controlled human exposure studies (second draft ISA, p 5-21). The effects of exercise and SO2 exposure in this population are not sufficiently understood, thus have the potential to influence these benchmarks.

   Also, noted in the REA (section 4.2.3.2. footnote 55), “that studies utilizing a mouthpiece to deliver pollutant concentrations cannot be directly compared to studies involving freely breathing subjects, as nasal absorption of SO2 is bypassed during oral breathing…” Although the comparison may not be directly made, the ratio of nasal to oral breathing shifts during exercise where there is more oral breathing if not all oral breathing. This would seem to be informative to conditions of breathing through a mouthpiece.

   b. **Plans for developing updated exposure-response functions, including the methodology, and specific studies to be relied on, for estimating exposure-response relationships for lung function decrements.** [Sections 3.2.2, 4.2.4]

      i. **The focus on specific airway responsiveness (sRaw) for this quantitative risk assessment of short-term exposure-related endpoints,**
ii. The range of exposure concentrations appropriate to include in the dataset for deriving the exposure-response function.

The data seem to support the proposed focus on sRAW for this quantitative risk assessment in terms of short-term endpoints.

The approach for selecting the range of exposure concentrations to include in the dataset seems appropriate and well-reasoned.

The additional analyses, deriving the E-R functions with and without higher exposure concentrations, seems important to investigate based on the 2009 REA and from the results presented in Figure 4-7 and Table 4-7.

3. The approach for assessing variability/co-variability and characterizing uncertainty in each part of the risk assessment and the approach for model sensitivity evaluations. [Section 4.4]

In some instances more recent survey data is available for factors such as physical attributes. Use of more recent data could reduce variability.

Body weight and surface area: Each simulated individual’s body mass was assigned using body mass distributions from the 1994-2004 NHANES data. More recent data is available and show a change in the body mass distributions. Presumably using more recent data could change the age- and sex-specific estimated BSA.

Recent data from the National Health Interview Survey show a higher prevalence of asthma in Blacks especially in Black children (15.4%).

This draft REA is based solely on exposure to sulfur dioxide. As known, and as noted in the comments for review of the ISA document (first draft), exposure to mixtures of pollutants, is what is experienced in the “real world” and may have greater health impacts than exposure to single pollutants. Are we at a point where a multipollutant approach can be explored for a primary standard, as is being explored for the secondary standards for sulfur oxides.

Other Comment

Many sections of the document are well written. However, there are sections that could be written in a clearer manner, as they require much deciphering to determine the information being conveyed (e.g. 3.2.2.).
Dr. Frank Speizer

Chapter 2

This is an excellent summary of what was done for the REA 2009 and provides an excellent road map of how to proceed with this current REA assessment. Both details of analytical procedures as well as limitations are discussed. The main issue in redoing this will be the hopefully far increase data base on 5 minutes (and 1 hour) daily averages and max/day.

Chapter 3

I would concur with the staff summary that the issues of change as summarized in chapter justify a redoing of the risk estimates. The two main issues are the far greater data base on 5-minute SO2 measurements and thus the ability to quantitatively reduce uncertainty in the estimates at or around the current standard (75ppb hourly). There will still be a range of values that will need to be studied. In addition, I would hope to see in Chapter 4 a discussion of relooking at the form of the standard (5min vs 1hour) as well as the number of exceedences above 98%ile vs 99%ile.

Chapter 4

Page 4-3, Use of APEX model seems justified

Page 4-5-6. The criteria for selection of potential sites seem reasonable down to 9 potential sites. Going from 9 to 4 seems more arbitrary and raises some concern, particularly as 3 or the 4 sites are contiguous with large bodies of water. The demography of the places selected also could influence results as the asthma rates may be particularly high and the proportion of African American will also be high. Need to discuss: why not use all 9 sites? It would seem to me that once the programs are written one need only turn the crank.

Page 4-14, Table 4-2: Are not the Maximum values the same by design? It would not appear that a max could be estimated from missing data. If so slightly misleading to put in table.

Page 4.16, 4.17 Table 4.3-4.4: For those of us that are naive re the use of formula 4.3 please plan for someone to demonstrate the calculation that produces the constant values in 4.3 for <2x only vs. in 4.4 for all four columns for C 1…C x.

Page 4.33 1st full paragraph. This paragraph discusses range of calculations as 100-400 ppb. Justification for lower bound is that group analysis at 200ppb is not significant. However, it is known that there are a small but significant number of individuals that do respond below 200 and thus under best case scenario and with an adequate margin of safety should be protected. I
suggest we need to quantify how large this group is to justify not protecting them; and therefore recommend that the analysis be run to 50 ppb. **Will need to discuss**

Page 4.34 end of first paragraph Description of how individual data will be used to construct APEX score raises concern about what will be categorized as responsive. For example in the Linn 1987 paper there are among the 40 asthmatics (mild=16, severe=24) several who responded to 0.2 with more than a 0.5l drop in FEV. (Although average drop was only about 150cc.). See above comment as I think this relates.

Section 4.2: Despite the numerous criticisms and comment above I found this whole section well written and the logic appropriate. One concern is that as far as I can tell all of the human exposure data that will be utilized is in adults with and without asthma. However, in section 4.2.4.2 mention is made of calculations for children and it is not clear what data base is being used for that. I suspect it is extrapolation of data from adults and if so should be stated.

Section 4.3 Discussion of Variability and Uncertainty. It is not as clear as it might be the relation between these two concepts. That is how does variability influence the characterization of uncertainty? When the calculation crosses the null it DOES NOT mean that the presence of an effect is null. Rather that, in most cases, there is insufficient data or too much variability for the amount of data there is to be confident of the central tendency and thus the magnitude of uncertainty will be higher. **Will need to be discussed.**