United States
Environmental
Protection Agency

EPA Science Advisory
Board (1400F)
Washington DC

EPA-SAB-ADV-05-XXX
October 2004
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IDENTIFYING AND CALCULATING ECONOMIC BENEFIT THAT GOES BEYOND AVOIDED AND/OR DELAYED COSTS: AN SAB DRAFT ADVISORY

A DRAFT ADVISORY OF THE ILLEGAL COMPETITIVE ADVANTAGE (ICA) ECONOMIC BENEFIT (EB) ADVISORY PANEL OF THE EPA SCIENCE ADVISORY BOARD

October 22, 2004

DRAFT DO NOT CITE OR QUOTE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C. 20460

OFFICE OF
THE ADMINISTRATOR
EPA SCIENCE ADVISORY BOARD

October 22, 2004

Note to the Reader:

The attached draft advisory of the EPA Science Advisory Board (SAB) is still undergoing internal SAB review. However, in its present form, it represents essentially a consensus position of the panel involved in this advisory activity. Once approved as final, the advisory will be transmitted to the EPA Administrator and will become available to the interested public.

This draft has been released for general information to members of the interested public and to EPA staff. This is consistent with the SAB policy of releasing draft materials only when the Panel involved is comfortable that the document is sufficiently complete to provide useful information to the reader. The reader should remember that this is an unapproved working draft and that the document should not be used to represent official EPA or SAB views or advice. Draft documents at this stage of the process often undergo significant revisions before the final version is approved and published.

The SAB is not soliciting comments on the advice contained herein. However, as a courtesy to the EPA Program Office which is the subject of the SAB review, we have asked them to respond to the issues listed below. Consistent with SAB policy on this matter, the SAB is not obligated to address any responses which it receives.

1. Has the Panel adequately responded to the questions posed in the Charge?
2. Are any statements or responses made in the draft unclear?
3. Are there any technical errors?

For further information or to respond to the questions above, please contact:

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October 22, 2004

EPA-SAB-ADV-05-XXX

The Honorable Michael O. Leavitt
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Subject: An Advisory of the Illegal Competitive Advantage (ICA) Economic benefit (EB) Advisory Panel of the EPA Science Advisory Board

Dear Administrator Leavitt:

The EPA Science Illegal Competitive Advantage (ICA) Economic Benefit Advisory Panel of the Science Advisory Board has completed its review of Agency's Office of Enforcement and Compliance Assurance (OECA) White Paper entitled *"Identifying and Calculating Economic Benefit That Goes Beyond Avoided and/or Delayed Costs,"* dated May 25, 2003. The Panel conducted its review in a public teleconference call on July 12 and a meeting August 5 & 6, 2004, followed by two public conference calls on September 22, and November 4, 2004. The results of the Panel's efforts were administratively reviewed and approved by the Board.

The EPA has made the violator's economic benefit from the violating the law the centerpiece of its calculation of civil penalties. The economic benefit from noncompliance consists of three possible components: (A) the economic benefit from *delayed costs* associated with noncompliance; (B) the economic benefit from *avoided costs* associated with noncompliance; and (C) the economic benefit from an *illegal competitive advantage* generated by non-compliance. The Agency identifies four categories of cases in which the economic gain of noncompliance with an environmental regulation will go beyond the benefit of delaying or avoiding compliance costs. It refers to these as "Illegal Competitive Advantage" (ICA). The four categories of cases are:

- violator gains additional market share;
- violator sells products or services prohibited by law;
- violator initiates construction or operation prior to government approval; and
- violator operates at higher capacity than it should have.

The Agency has asked our advice regarding these categories and the proposed methods for estimating economic for each.

The fundamental question for the determination of a penalty based on economic benefit is how much did the profits of the firm increase as a result of its noncompliance. Profits can be increased either by an increase in revenue or a decrease in the total cost of production (including abatement costs), or some combination of both. The Agency's White Paper has essentially placed all of the factors influencing revenues in one of the four categories under the heading of "benefit from illegal competitive activity."

For several reasons, the Panel finds that the Agency's use of the term "illegal competitive advantage" and its identification of the four categories of ICA cases is unhelpful.

1. It is not clear what the modifier "competitive" is intended to convey.

2. Increases in market share will often be difficult to identify, requiring comparison of the noncompliance scenario with the counterfactual compliance scenario, even if observed increases in market share might be difficult to attribute to the noncompliance.

3. Increases in market share are not inherently valuable to the firm; what matters is the impact of changes in market share on profits.

4. The other categories of ICA appear to be unusual circumstances that are very context dependent.

It would be more transparent to have only two categories: (i) firms experienced no revenue increase and violators' profits were increased by the amount of the delayed or avoided compliance costs; and (ii) all others. For all of those cases in which revenues increase, we recommend that the Agency examine the facts of each case and use methods and data appropriate to the case to estimate the changes in streams of revenue and/or production costs as well as delayed or avoided compliance costs (if any).

The Panel also considered some broader issues relating to the determination of the magnitude of penalties for noncompliance. We believe that one of these is of particular importance to you. This is the economic theory of optimal penalties.

This theory makes two points that are relevant to EPA's penalty policy. The first is based on the assumption that potential offenders respond to both the probability of detection and the severity of punishment if detected and convicted. Thus, deterrence may be enhanced by raising the penalty, by increasing monitoring activities to raise the likelihood that the offender will be caught, or by changing legal rules to increase the probability of conviction. And second, the economically optimal penalty balances the harm done by an offense against the cost of deterring the offense in one or another of these ways. This balancing leads to the conclusion that the appropriate methodology for calculating a penalty is to charge an amount per offense equal to the (monetized) harm done divided by the probability of punishment.

The Panel believes that the state-of-the-art in benefits estimation has progressed to the point where EPA should seriously explore how it might incorporate "harm-based" measures into its penalty formula, at least for some types of environmental harm. We also recommend that the Agency explore ways to incorporate more explicitly the probability of detection and conviction into its penalty policy as a way of making more effective the deterrent effects of its penalties

We are pleased to have participated in this process and are particularly interested in your response to the points we raise in this report.

Sincerely,

Dr. William Glaze, Chair
EPA Science Advisory Board

Dr. A. Myrick Freeman, Chair
Illegal Competitive Advantage (ICA) Economic Benefit (EB) Advisory Panel
EPA Science Advisory Board

NOTICE

This report has been written as part of the activities of the EPA Science Advisory Board, a public advisory committee providing extramural scientific information and advice to the Administrator and other officials of the Environmental Protection Agency. The Board is structured to provide balanced, expert assessment of scientific matters related to problems facing the Agency. This report has not been reviewed for approval by the Agency and, hence, the contents of this report do not necessarily represent the views and policies of the Environmental Protection Agency, nor of other agencies in the Executive Branch of the Federal government, nor does mention of trade names or commercial products constitute a recommendation for use. Reports of the EPA Science Advisory Board are posted on the EPA website at http://www.epa.gov/sab.

ABSTRACT

The U.S. Environmental Protection Agency's Illegal Competitive Advantage (ICA) Economic Benefit (EB) Advisory Panel ("the Panel") provided advice on four charge questions relating to an Agency White Paper entitled *"Identifying and Calculating Economic Benefit That Goes Beyond Avoided and/or Delayed Costs,"* dated May 25, 2003.

The EPA has made the recovery of a violator's economic benefit from violating the law the basis of its calculation of civil penalties. The Agency has asked the Panel for advice in estimating economic benefits when a firm's noncompliance enables it to increase sales (which it terms "illegal competitive advantage" or ICA) , as opposed to simply avoiding or delaying compliance costs. The Panel suggests that the four categories of cases of under the term ICA described in the White Paper are not helpful for several reasons.

The Panel suggests that in all those cases in which revenues increase, the Agency should examine the facts of each case and use methods and data appropriate to the case to estimate the changes in streams of revenue and/or production costs, as well as any delayed or avoided compliance costs.

After a review of the economic theory of optimal penalties, the Panel recommends that the Agency explore ways to explicitly incorporate the probability of detection and conviction into its penalty policy. The Panel also believes that the state-of-the-art in benefits estimation has progressed to the point where EPA should seriously explore how it might incorporate "harm-based" measures into its penalty formula, at least for some types of harm.

Key Words: Compliance, Economic Benefit, Economic Gain, Enforcement, Harm-Based Measures, Illegal Competitive Advantage, Optimal Penalties

U.S. Environmental Protection Agency
Science Advisory Board
Illegal Competitive Advantage (ICA) Economic Benefit (EB) Advisory Panel

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1. EXECUTIVE SUMMARY

The Illegal Competitive Advantage (ICA) Economic Benefit (EB) Advisory Panel of the EPA Science Advisory Board (SAB) reviewed and evaluated a White Paper entitled. *"Identifying and Calculating Economic Benefit That Goes Beyond Avoided and/or Delayed Costs,"* dated May 25, 2003, as well as supplemental materials, along with a charge for the Panel. The Panel held a conference call on July 12, 2004, met in Washington, DC, on August 5-6, 2006, and conducted follow-up conference calls on September 22 and November 4, 2004 to conclude its activity.

1.1 Current Civil Penalty Policy at the Agency

Since 1978, the EPA has made the violator's economic benefit from the violating the law the centerpiece of its calculation of civil penalties. The economic benefit from noncompliance consists of three possible components: (A) the economic benefit from *delayed costs* associated with noncompliance; (B) the economic benefit from *avoided costs* associated with noncompliance; and (C) the economic benefit from an *illegal competitive advantage* generated by non-compliance. The EPA's request to the SAB deals with one aspect of just one of these three stages in the development of a penalty target, the assessment of illegal competitive advantage in the calculation of economic benefit.

The EPA *Policy on Civil Penalties* establishes "a single set of goals for penalty assessment in EPA administrative and judicial enforcement actions." These goals are characterized as "deterrence, fair and equitable treatment of the regulated community, and swift resolution of environmental problems (U. S. EPA, 1984a, p. 1)." We focus on the first two items – *fairness* and *deterrence* – as primary objectives in the determination of a civil penalty.

The deterrence objective is clearly recognized in the EPA's penalty process. But one consideration that plays a substantial role in the economic theory of deterrence appears to be entirely missing from the current penalty assessment process; this is the probability of detection and conviction associated with the violation in question.

An important aspect of fairness is the *restoration of the status quo*: the law has been violated and one objective of the penalty system is to return the status quo before the violation occurred.. Requiring the polluter to surrender the profit he gained by not complying with the law is one important aspect of restoration of the status quo. However, removing the economic benefit is not the *only* action that might be required in order to restore the status quo. With a violation of an environmental regulation, there is a loss resulting from the polluter's action in the form of some harm to the natural environment. Whether the natural resource that is harmed belongs to a private individual or the general public, restoration of the status quo can call for some appropriate compensatory action, perhaps in the form of a penalty based on harm to the environment rather than on gain to the polluter.

These two points raise issues that lie outside of the charge to the Panel. Nevertheless the Panel believes that they deserve consideration in the continuing evolution of the Agency's civil penalty policy. Further discussion is deferred to the concluding section of this report.

Regarding the calculation of economic gain, the Agency developed the BEN model to estimate the economic benefits that result from cost-savings during the time that a facility is not in compliance. Because BEN is presently limited to calculating the difference in discounted cash flows that result from cost-savings during non-compliance, it is not now configured to support recapture of benefits that could result from higher revenues. There is no inherent reason that BEN could not be modified so that it could be used to estimate the benefits of higher revenues.

In its White Paper the Agency identifies four categories of cases in which the economic gain of noncompliance with an environmental regulation will go beyond the benefit of delaying or avoiding compliance costs. It refers to these as "Illegal Competitive Advantage" (ICA). The four categories of cases are:

- violator gains additional market share;
- violator sells products or services prohibited by law;
- violator initiates construction or operation prior to government approval; and
- violator operates at higher capacity than it should have.

The Agency has asked our advice regarding these categories and the proposed methods for estimating economic for each.

1.2. The Panel's Responses

The fundamental question for the determination of the economic benefit component of the penalty is how much did the profits of the firm increase as a result of its noncompliance. Profits can be increased either by an increase in revenue or a decrease in the total cost of production (including abatement costs), or some combination of both. The BEN model provides a reliable measure of the change in before-tax profit only if no other change would have occurred that would have affected the firm's profit. The Agency's White Paper has essentially placed all of the other factors that might influence the amount by which the violator's profit was increased by the violation in one of the four categories under the heading of "benefit from illegal competitive activity."

For several reasons, the Panel finds that the Agency's use of the term "illegal competitive advantage" and its identification of the four categories of ICA cases is unhelpful.

1. It is not clear what the modifier "competitive" is intended to convey.

2. Increases in market share will often be difficult to identify in terms of comparing the noncompliance scenario with the counterfactual compliance scenario; and observed increases in market share might be difficult to attribute to the noncompliance.

3. Increases in market share are not inherently valuable to the firm; what matters is the impact of changes in market share on profits.

4. The other categories of ICA appear to be unusual circumstances that are very context dependent.

It would be more transparent to have only two categories: (i) firms experienced no revenue increase and violators' profits were increased by the amount of the delayed or avoided compliance costs; and (ii) all others. The BEN model would be applicable for those cases that fit

into the first category. But for all other cases, we recommend that the Agency examine the facts of each case and use methods and data appropriate to the case to estimate the changes in streams of revenue and/or production costs as well as delayed or avoided compliance costs (if any).

A fundamental issue is how to estimate economic benefit when a violator sells more output leading to greater revenues than it would have earned if it had been in compliance. The benefit from increased sales is the profits they generate. A key point of potential confusion is whether (or when) profits on increased sales should be added to avoided/delayed costs as opposed to being a substitute measure of economic benefit. We use a simple economic model to identify the economic gain due to noncompliance. We show that when a firm is able to increase sales, using avoided costs at the actual quantity produced overstates the true economic benefits of noncompliance.

There are two situations in which a calculation of economic benefit based only on avoided/delayed costs could still be justified. The first is if it can be assumed that the effect on marginal cost and therefore output is sufficiently small that the error induced by ignoring output effects is also small. The second is if compliance would affect fixed costs only. In that case, compliance would leave marginal cost and, accordingly, output unchanged.

We have now completed enough of our analysis to provide most of our answers to the four charge questions.

1. **Are there categories of cases that would be useful for the Agency to consider in calculating the ICA economic benefit, other than those that are identified in the White Paper? Should any of these be combined?**

We do not think that the categories offered in the White Paper are particularly useful. In fact we believe that they should be combined into only one category - cases where profits increase at least in part due to increases in revenue.

2. **How can the Agency more accurately characterize the types of cases that are described in the White Paper? Have any of the examples and counter-examples in the White Paper been misidentified with regard to whether they are amenable to the BEN model's simplifying paradigm?**

This is not relevant given our answer to question 1.

3. **Are there any suggestions for modifying the described analytical approach to calculate the economic benefits and;**

We believe that there is no substitute for a careful examination of the facts of each case and the use of methods and data appropriate to each case to estimate the changes in streams of revenue and/or production costs as well as delayed or avoided compliance costs (if any).

4. **The Agency's proposed approach strives to avoid double-counting of the benefit by laying out all relevant cash flows stemming from the violations, as opposed to simply adding on the additional calculations to a BEN run. What additional measures (if any) should the Agency put in place to avoid such potential double-counting?**

Every effort should be made to calculate economic advantage as avoided/delayed costs (and therefore not to decompose the gain into separate components.) One should only resort to a full-blown change in profit analysis when avoided/delayed costs leads to a clearly substantial overestimate of the economic benefit. If it is necessary to do change-in-profit analysis, it is important that the estimate of costs under compliance reflect the lower level of output the firm would have produced rather than the actual production of the polluter.

1.3. Additional Issues

1.3.1. The Effect of Market Structure

The conclusion that measures of delayed and avoided cost overstate economic benefit applies to competitive markets as well as to the monopoly case we modeled. Whether the point is true in oligopoly is less clear. Different models of oligopoly behavior yield different conclusions. Cases might arise in which the Agency would want to compute profits from increased sales based on an underlying model of oligopoly. Since the appropriate choice among competing models would likely depend on the details of the violator's industry, the committee cannot recommend a standard approach.

1.3.2. Dynamic Effects

To this point, we have implicitly assumed that economic benefit from non-compliance arises during the period of non-compliance. There are several reasons, however, why non-compliance could have enduring effects. The violator might gain customers who remain loyal. There might be "learning curve" effects that give it strategic advantages in future periods. The presence of dynamic effects does not alter the point that avoided/delayed costs over-estimates economic gains when the polluter increases sales. If the firm sells more by virtue of not complying and those sales increase future profits, then the value of those future profits is part of the economic gain from non-compliance. But the extent and duration of the profit increase is likely to be hard to measure.

1.3.3. Ex Ante vs. Ex Post Assessments

The definition of "economic benefit" used by EPA is fundamentally *ex post.* That is, it asks how much the **realized** economic gain was between the actual noncompliance scenario and the hypothetical compliance situation. An alternative would be to use an *ex ante* definition, under which the appropriate measure would be the economic gain **expected** to be obtained by violating the rule or statute. To determine which approach is most appropriate, it is necessary, first, to consider the goal of the economic benefit assessment. If the purpose is to recapture the economic benefit that is gained illegally, an ex post approach will often be sufficient to return the firm to original conditions.

There are however, some situations in which *ex post* calculations will fail to achieve EPA's modest goal of "leveling the playing field." In general, these can occur when part of the reason a firm decides to violate involves uncertainty about the value that a random variable affecting profits will take. An ex ante measure is conceptually robust because it accommodates dynamic market events and decision making under uncertainty. Although an *ex ante* measure of the change in profits may be the preferred measure conceptually, usually an ex post measure of change in profits is the only practical and replicable approach. This is because an *ex ante* measure requires a reconstruction of uncertainty facing the firm at earlier points in time.

1.3.4. Estimating Compliance Costs - Going Beyond "End-of-Pipe" Technologies

The Agency's approach to calculating delayed or avoided compliance costs is based on the assumption that the firm will comply with the pollution control regulation by adding on some sort of "end-of-pipe" device whose costs depend only on the quantity of residuals being generated and the level of abatement that is sought. This assumption will not always be valid. The choice of input quality, product mix from a multiproduct plant, production process design and operating conditions, and of output quality will all have impacts on the marginal costs of controlling pollution discharges to air, water, and solid waste handling facilities.

For the EPA's penalty policy, the obvious problem raised by this observation is that getting the cost saving from non-compliance right in principle will require detailed knowledge of the individual facility, its inputs, outputs, and processes. Estimating the costs of an end-of pipe device that could have produced compliance will produce an estimate of delayed or avoided compliance costs that will never be too small. This estimate can be the starting point for negotiations. If a violator wants to contest the penalty thus produced, it would be that firm's responsibility to convince technical reviewers that an alternative combination of production and treatment would have done the same job more cheaply.

1.4. Toward an Optimal Penalty Policy

The economic theory of optimal penalty approaches the issue of deterrence from the perspective of economic efficiency rather than that of fairness. This theory makes two points that are relevant to EPA's penalty policy. The first is based on the assumption that potential offenders respond to both the probability of detection and the severity of punishment if detected and convicted. Thus, deterrence may be enhanced by raising the penalty, by increasing monitoring activities to raise the likelihood that the offender will be caught, or by changing legal rules to increase the probability of conviction. And second, the economically optimal penalty balances the harm done by an offense against the cost of deterring the offense in one or another of these ways. This balancing leads to the conclusion that the appropriate methodology for calculating a penalty is to charge an amount per offense equal to the (monetized) harm done, divided by the probability of punishment.

If an environmental violation results in emissions levels that are beyond a legal standard, there is likely to be some harm to natural resources or human health. Measuring people's value for non-market items in monetary terms (e.g., measuring what they would be willing to pay to prevent a specific harm to the natural environment) is inherently difficult, and in practice different measurement techniques can produce different results. Nevertheless, the Panel believes that the state-of-the-art in benefits estimation has progressed to the point where EPA should seriously explore how it might incorporate "harm-based" measures into its penalty formula, at least for some types of environmental harm. We recognize that while some of the methods used to value environmental harm can be employed with relatively little cost, others require significant resources. Thus, in many cases, these methods may not be practical unless the harm and thus expected penalty is extremely large. But these are likely to be the cases that result in very significant and quantifiable harm. Furthermore, since the EPA already makes extensive use of non-market valuation to assess the efficacy of its environmental protection programs and policies, it seems to us appropriate that the Agency should in principle be prepared to apply these same techniques, at least in some cases, to assess the value of the damage when the environmental laws are violated.

The probability of detection is likely to vary considerably by type of violation and even across jurisdictions. An extremely harmful environmental violation is likely to have a probability of detection and punishment of nearly one. If so, the optimal penalty for such a violation is likely to be the monetary equivalent of harm. However, as the size of the harm decreases, all else equal, we expect that the likelihood of detection also decreases. Other factors that might influence the probability of detection and conviction are: (a) whether or not a violator is subject to mandatory reporting that is available to the public to scrutinize and file citizen lawsuits, (b) the ratio of facilities to inspectors in an EPA region, (c) the strength of environmental activism in a region/state, and (d) whether or not the violator had a history of violations and thus was subject to increased scrutiny or targeted enforcement.

Although not widely employed in the environmental literature to date, numerous techniques are available to estimate the probability of detection and punishment. One widely used method is the "time till capture" approach which is most appropriate for ongoing violations that occur over a period of time. Another method - the "capture/recapture" approach has its foundation in estimating the number of animals in a given geographic area.

The current EPA Penalty Policy starts with the calculation of "gain" – i.e. estimating the amount that the offender saved by not complying with environmental regulations, and then adds a "gravity" component based in part on the harm from the offense. However, the policy does not provide for quantifying the "harm" and also ignores any explicit consideration of the probability of detection. An alternative approach that might be explored by EPA would be to provide for a "base" fine that is predicated on the harm. If harm cannot be quantified, the base might either be "gain" or a "default" fine level that is specified by type of offense. This base fine would then be multiplied by a factor that is based on the probability of detection.

2. INTRODUCTION

2.1 Request for EPA Science Advisory Board (SAB) Review

At the request of the EPA Office of Compliance and Assurance (OECA), the EPA Science Advisory Board convened a Panel to review and evaluate a White Paper entitled *"Identifying and Calculating Economic Benefit That Goes Beyond Avoided and/or Delayed Costs,"* dated May 25, 2003, as well as supplemental materials, along with a charge for the Panel. The White Paper identifies four categories of cases in which the economic gain of noncompliance with an environmental regulation will go beyond the benefit of delaying or avoiding compliance costs, provides examples and counterexamples of each, and briefly describes how the economic gain can be calculated. The four categories of cases are:

- violator gains additional market share;
- violator sells products or services prohibited by law;
- violator initiates construction or operation prior to government approval; and
- violator operates at higher capacity than it should have.

The proposed charge to the ICA EB Advisory Panel of the SAB was developed based on discussions between the OECA and SAB Staff offices. The specific charge questions are presented in Section 3.5 below.

2.2 The Quality Review Process

A Quality Review Subcommittee (QRS) was formed to critique the ICA EB Advisory Panel draft report. This review process identified the following issues: (to be completed when this occurs - - - KJK)

2.3 Review and Transmittal

The Board approved the Panel's report on (add date, e.g., January XX, 2005 and transmitted the report to the Agency. For that review, the Panel report, ...(to be completed when this occurs - - - KJK)

3. CURRENT AGENCY PRACTICE AND QUESTIONS FOR THE PANEL

3.1 Statutory Provisions and the EPA Penalty Policy - Recapture Economic Gain

The US Environmental Protection Agency exercises primary enforcement responsibility for many of the federal environmental protection laws, including the Clean Air Act; the Clean Water Act; the Oil Pollution Act; the Safe Drinking Water Act; the Federal Insecticide, Fungicide, and Rodenticide Act; the Toxic Substances Control Act; the Resource Conservation and Recovery Act; the Comprehensive Environmental Response, Compensation, and Liability Act; and the Emergency Planning and Community Right-to-Know Act. While each of the statutes is different in its particulars, they generally provide for the assessment of civil penalties in the event of non-compliance, and they offer some guidance as to the considerations that should be considered when assessing a civil penalty. For example, Section 7413(e)(1) of the Clean Air Act states:

> In determining the amount of any penalty to be assessed under this section or section 7604(a) of this title, the Administrator or the court, as appropriate, shall take into consideration (in addition to such other factors as justice may require) the size of the business, the economic impact of the penalty on the business, the violator's full compliance history and good faith efforts to comply, the duration of the violation as established by any credible evidence (including evidence other than the applicable test method), payment by the violator of penalties previously assessed for the same violation, *the economic benefit of noncompliance,* and the seriousness of the violation [emphasis added].

In addition, Section 7524(b) of the Act states:

> In determining the amount of any civil penalty to be assessed under this subsection, the court shall take into account the gravity of the violation, *the economic benefit or savings (if any) resulting from the violation*, the size of the violator's business, the violator's history of compliance with this title, action taken to remedy the violation, the effect of the penalty on the violator's ability to continue in business, and such other matters as justice may require [emphasis added]..

Since 1978, the EPA has implemented these directives for civil penalties, and similar ones in other laws, by making the violator's economic benefit from the violating the law the centerpiece of the penalty calculation (EPA "Civil Penalty Policy" 1978) The monetary estimate of the economic benefit from noncompliance becomes the starting point for establishing a penalty, and this is then adjusted up or down based on a qualitative assessment of other considerations such as the factors listed above. This approach was further formalized in February 1984 when the EPA issued the *Policy on Civil Penalties*, EPA Enforcement Policy #GM-21 and the accompanying *Framework for Statute-Specific Approaches to Penalty Assessments*, EPA General Enforcement Policy #GM-22. As explained in the latter document: "The development of a penalty figure is a two-step process. First the case development team must calculate a preliminary deterrence figure. This figure is composed of the economic benefit component (where applicable) and the gravity component. The second step is to adjust the preliminary deterrence figure through a number of factors (U. S. EPA, 1984b, p. 2)."

According to the 1984 Guidelines, the economic benefit from noncompliance consists of three possible components: (A) the economic benefit from *delayed costs* associated with noncompliance; (B) the economic benefit from *avoided costs* associated with noncompliance; and (C) the economic benefit from an *illegal competitive advantage* generated by non-compliance.

Following the assessment of the economic benefit, the EPA then performs an assessment of the gravity component. This involves ranking different types of violations according to the seriousness of the act, considering (i) actual or possible harm, (ii) importance to the regulatory scheme, and (iii) availability of data from other sources. In evaluating the actual or possible harm, consideration should be given to (a) the amount of pollutant, (b) toxicity of pollutant, (c) sensitivity of the environment, (d) length of time of a violation, and (e) size of the violator. Having ranked the violations, according to the 1984 Guidelines one "then should assign appropriate dollar amounts or ranges of amounts to the different ranked violations to constitute the 'gravity component'. This amount, added to the amount reflecting benefit, constitutes the preliminary deterrence figure (U. S. EPA, 1984b, p. 3)."

In the second step, the preliminary deterrence amount is adjusted "to ensure that penalties also further Agency goals besides deterrence (i.e. equity and swift correction of environmental problems). … Adjustments (increases or decreases, as appropriate) that can be made to the preliminary deterrence penalty to develop an initial penalty target to use at the outset of negotiation include:

a. degree of willfulness and/or negligence
b. cooperation/noncooperation through pre-settlement action
c. history of noncompliance
d. ability to pay
e. other unique factors (including strength of case, competing public policy considerations) ((U. S. EPA, 1984ba, pp. 3-4)."

In summary, the dollar amount which the EPA presents as its initial penalty target is derived by calculating the economic benefit, adding a monetary amount which reflects the gravity component, and adjusting the resulting total up or down based on the considerations listed immediately above.

The EPA's request to the SAB deals with one aspect of just one of these three stages in the development of a penalty target, the assessment of illegal competitive advantage in the calculation of economic benefit. Nevertheless, before we address this question, it is useful to situate the penalty procedure in the broader context of the economic and public policy considerations that bear on the determination of a penalty for noncompliance with environmental regulations.

3.2 The Objectives of Penalties

The EPA *Policy on Civil Penalties* establishes "a single set of goals for penalty assessment in EPA administrative and judicial enforcement actions." These goals are characterized as "deterrence, fair and equitable treatment of the regulated community, and swift resolution of environmental problems (U. S. EPA, 1984a, p. 1)." In the context of our present analysis, we see the last item as being more a *constraint* than an objective: whatever the formula for assessing a civil penalty, it needs to be practical and susceptible of implementation in a

reasonably timely manner. Accordingly we focus on the other two items – *fairness* and *deterrence* – as primary objectives in the determination of a civil penalty; they are clearly evident in the statutory provisions quoted above.

Deterrence and, especially, fairness have multiple possible interpretations depending on both the philosophical position one adopts and how one interprets the violation of an environmental law from a public policy perspective. In this section we note some issues that arise in conceptualizing the objectives of fairness and deterrence.

An important aspect of fairness is what might be called the *restoration of the status quo*: the law has been violated and the restorative objective of a penalty system is to undo the violation and return the situation to how it was before the violation occurred. This is clearly the major focus of the EPA's civil penalty policy since 1978. The assumption underlying this policy is that the noncompliance with environmental regulations was associated with, and perhaps motivated by, some increase in profit to the responsible party (from now on, we will use "the polluter" as a shorthand term to refer to this party). Whether or not the assumption is correct is obviously an empirical question that depends on the particular circumstances of the case; but, for now, we will assume it is correct. In that case, a key element of the restoration of the status quo is to compel the polluter to surrender the profit he gained by not complying with the law. This is essentially what the EPA Penalty Policy focuses on by virtue of the prominent position it accords to the calculation of economic benefit.

It should be noted, however, that removing the economic benefit is not the *only* action that might be required in order to restore the status quo. This is because the failure to comply with a federal regulation may entail not only an unwanted gain to the violator but also an unwanted loss to some other party. In the case of violation of an economic regulation, for example, a violation of anti-trust law may generate not only an unlawful gain to the seller but also an unwanted loss to the customers who purchase from this seller. In that case, the restoration of the status quo requires not only that the seller surrender his unlawful gain but also that the customers be compensated for their unlawful loss. With a violation of an environmental regulation, while there may not be an unwanted monetary loss to a third party there certainly is a non-monetary loss resulting from the polluter's action in the form of some harm to the natural environment. Whether the natural resource that is harmed belongs to a private individual or the general public, a loss has occurred, and restoration of the status quo calls for some appropriate

compensatory action. Depending on the circumstances, this action could include both clean-up and some form of environmental restoration.[1] The costs of clean-up and environmental restoration are thus compensation that should be paid by the polluter in order to restore the status quo.

The popular name for what is being discussed here is "the polluter pays principle." Not only is this called for by notions of fairness, but also it is supported by considerations of economic efficiency. Ever since Pigou (1918), it has been recognized that, in the presence of a harmful externality such as that caused by pollution, a competitive market is generally unlikely to lead to a socially optimal allocation of resources unless the polluter is required to bear the cost that his pollution imposes on others.

In summary, the restoration of the status quo would appear to be an important aspect of the fairness objective in setting the penalty for a violation of an environmental regulation. This restorative goal can be seen to have two possible implications. If one focuses on the polluter's unlawful gain, restoration of the status quo implies that he should give up this gain. If one focuses on the unlawful harm to the environment, restoration of the status quo implies that he should pay an amount covering the cost of cleanup and/or environmental restoration. In general, there is no reason to expect that the two different approaches lead to a similar assessment of a monetary payment: the cost avoided by failing to control pollution need bear no relationship to the damage caused by the pollution. This raises two questions: Which approach is presently adopted by the EPA. Which approach seems preferable, or should they be combined in some manner?

With regard to the first question, it must be recognized that the current EPA penalty policy does contain some elements of both approaches, but they are combined in a manner that is equivocal and perhaps somewhat muddled. The first step in the penalty assessment process, the calculation of economic benefit, focuses on the unlawful gain to the polluter. The second step, the assessment of the gravity component, contains elements that clearly relate to the unlawful

[1] With respect to the latter, although the context is different, it strikes us as relevant to quote the language used by the Department of Interior (DOI) in its proposed regulations for natural resource damages under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA); DOI describes the measure of damages as: "the cost of restoration, rehabilitation, replacement, and/or acquisition of the equivalent of the injured natural resources and the services those resources provide, plus the compensable value of the services lost to the public for the time period from the discharge or release until the attainment of the restoration, rehabilitation, replacement and/or acquisition of equivalent of the resources and their services to the baseline." (56 Fed. Reg. at 19,769 (proposed 43 C.F.R. § 11.80(b)).

loss to the environment, specifically item (i), the actual or possible harm. But, the characterization of this item is somewhat confusing because, while it includes factors that relate directly to the magnitude of the environmental damage -- the amount of pollutant, the toxicity of pollutant, the sensitivity of the environment, and the length of time of a violation – it also includes a factor (the size of the violator) that has nothing to do with the amount of environmental damage. We see the last item as being relevant to the deterrence objective of a penalty rather than the restoration of the status quo.

The two other elements of the gravity component in the EPA penalty process also call for some comment. One of these, the availability of data from other sources, strikes us as something that should be viewed as a constraint on the assessment of a penalty rather than a determinant of the gravity of the offense. With regard to the other, the importance of the violation to the regulatory scheme, it is unclear to us whether this meaningfully recognizes the magnitude of the environmental damage caused by the violation. Furthermore, it is not clear to us whether there is any systematic way by which the gravity component is used in practice to modify the dollar amount assessed in the economic benefit stage

In short, the current EPA penalty process appears to focus overwhelmingly on the calculation of the unlawful gain to the polluter, with no systematic consideration of the monetary value of the environmental damage caused by the violation of the pollution control regulation. We return to this issue in Section 6, below..

The deterrence objective is certainly recognized in the EPA's penalty process. In addition to the item in the gravity component stage, noted above, the third stage of the process, the adjustment stage, is heavily weighted to factors that bear on deterrence, including the degree of willfulness and/or negligence, the extent of cooperation through pre-settlement action, the history of noncompliance, and the polluter's ability to pay. But one consideration that plays a substantial role in the economic theory of deterrence appears to be entirely missing from the current penalty assessment process; this is the probability of detection and conviction associated with the violation in question. Economic theory indicates that, to obtain a given degree of deterrence, the penalty should vary inversely with the probability of detection: given two possible violations with the same economic benefit to the polluter but where one is much less likely to be detected than the other, the former requires a larger penalty in order to provide the same degree of deterrence. We also return to this question in Section 6, below.

3.3. Delayed and Avoided Compliance Costs and the BEN Model

Since 1984, a key EPA objective in assessing civil penalties has been to deter violators. The "cornerstone" of achieving this goal is to recapture the economic benefit that accrues from non-compliance, so that facility operators/owners are indifferent between compliance and non-compliance. The BEN model, first issued in late 1984, was developed to estimate the economic benefits that result from cost-savings during the time that a facility is not in compliance. As such, it can estimate savings from deferred capital investments in control equipment, deferred one-time expenditures (such as establishing accounting/tracking systems), and reduced recurring costs of maintaining and operating control systems.

The model is simple to run, requiring the user to provide a minimal amount of information to estimate cost-savings. Standard values, for things such as tax rates, the cost of capital, and equipment life are embedded in the model itself (although they can be modified by the user), and are determined by the user's response to a set of "screening questions." Since the BEN model became a central tool in the penalty assessment process annual penalty assessments have risen dramatically. It is not possible to entirely untangle the impact of BEN from the impact of changes in EPA enforcement policies, but it seems apparent that it has been a factor in this increase.

Because BEN is presently limited to calculating the difference in discounted cash flows that result from cost-savings during non-compliance, it is not now configured to support recapture of benefits that could result from higher revenues. Viewed as a calculator, there is no inherent reason that BEN could not be used to estimate the benefits of higher revenues. This would require construction of specific questions for the user to respond to, parallel to the present questions that prompt the user to enter relevant information regarding differences in costs that result from non-compliance.

In cases where greater revenues might be a significant incentive to be non-compliant, adding questions that would support estimation of differences in discounted *net* cash flows would be useful and, in fact, critical to deterrence.

3.4 The Four Categories of Illegal Competitive Advantage

The White Paper identifies four categories of cases in which the economic gain of noncompliance with an environmental regulation will go beyond the benefit of delaying or avoiding compliance costs. It refers to these as "Illegal Competitive Advantage" (ICA). It also provides examples and counterexamples of each category and briefly describes how the economic gain can be calculated. The four categories of cases are:

- violator gains additional market share;
- violator sells products or services prohibited by law;
- violator initiates construction or operation prior to government approval; and
- violator operates at higher capacity than it should have.

3.5 The Charge Questions for The Panel

The specific charge questions are:

1. Are there categories of cases that would be useful for the Agency to consider in calculating the ICA economic benefit, other than those that are identified in the White Paper? Should any of these be combined?

2. How can the Agency more accurately characterize the types of cases that are described in the White Paper? Have any of the examples and counter-examples in the White Paper been misidentified with regard to whether they are amenable to the BEN model's simplifying paradigm?

3. Are there any suggestions for modifying the described analytical approach to calculate the economic benefits and;

4. The Agency's proposed approach strives to avoid double-counting of the benefit by laying out all relevant cash flows stemming from the violations, as opposed to simply adding on the additional calculations to a BEN run. What additional measures (if any) should the Agency put in place to avoid such potential double-counting?

4. THE PANEL'S RESPONSES

4.1 The Economic Benefit is the Increase in Profits

For several reasons, the Panel finds that the Agency's use of the term "illegal competitive advantage" and its identification of the four categories of ICA cases is unhelpful.

1. It is not clear what the modifier "competitive" is intended to convey.

2. Increases in market share will often be difficult to identify in terms of comparing the noncompliance scenario with the counterfactual compliance scenario; and observed increases in market share might be difficult to attribute to the noncompliance.

3. Increases in market share are not inherently valuable to the firm; what matters is the impact of changes in market share on profits.

4. The other categories of ICA appear to be unusual circumstances that are very context dependent.

The fundamental question for the determination of the economic benefit component of the penalty is how much did the profits of the firm increase as a result of its noncompliance. Profits can be increased either by an increase in revenue or a decrease in the total cost of production (including abatement costs), or some combination of both. The BEN model provides a reliable measure of the change in before-tax profit only if no other change would have occurred that would have affected the firm's profit. This is an empirical question that should be explored and not assumed. The Agency's White Paper has essentially placed all of the other factors that might influence the amount by which the violator's profit was increased by the violation in one of the four categories under the heading of "benefit from illegal competitive activity." It would be more transparent to have only two categories: (i) firms experienced no revenue increase and violators' profits were increased by the amount of the delayed or avoided compliance costs; and (ii) all others.

The BEN model would be applicable for those cases that fit into the first category. But for all other cases, we recommend that the Agency examine the facts of each case and use methods and data appropriate to the case to estimate the changes in streams of revenue and/or production costs as well as delayed or avoided compliance costs (if any).

4.2 Economic Benefit When Revenues Change Due to Noncompliance

A fundamental issue addressed by the White Paper is how to estimate economic benefit when a violator sells more output leading to greater revenues than it would have earned if it had been in compliance. The benefit from increased sales is the profits they generate. A key point of potential confusion is whether (or when) profits on increased sales should be added to avoided/delayed costs as opposed to being a substitute measure of economic benefit.

Figure 1 illustrates the issues. The downward-sloping line is the demand curve faced by a firm. The two solid horizontal lines represent unit costs when the firm is and is not in compliance with EPA regulations.[2] QC and PC are the profit-maximizing quantity produced and price charged when the firm is in compliance while QN and PN are the profit-maximizing quantity and price when the firm is not in compliance. The graph represents a case based on the implicit assumption that the violator is a monopolist or a monopolistic competitor, and in which non-compliance lowers marginal cost and therefore causes the firm to produce more than it otherwise would.

When the firm complies with regulations, its profits are the sum of areas A and B. When it does not comply, its profits are the sum of B, C, D, and E. The economic benefit is, therefore, the difference between the two, or C + D + E – A. This benefit is difficult to calculate, because all that is observed is the actual prices and quantities (QN and PN). Calculating the true economic benefit requires estimating the quantities that would have been produced, and the prices that would have been charged, if the firm had complied (QC and PC).

If instead of calculating the true economic benefits, the EPA uses avoided costs at the quantity actually produced, that measure in figure 1 would be areas C + D. This avoided cost

2 The graph as drawn is based on the assumption of constant returns to scale both with and without compliance. That assumption simplifies the graph because it implies that marginal and average cost are equal to each other.

measure differs from the true measure by the amount A – E, and it is a general proposition in economics that A is greater than E. (If it were not, a compliant firm could make more profits by producing QN than QC.) Thus, using avoided costs at the actual quantity produced overstates the true economic benefits of noncompliance.

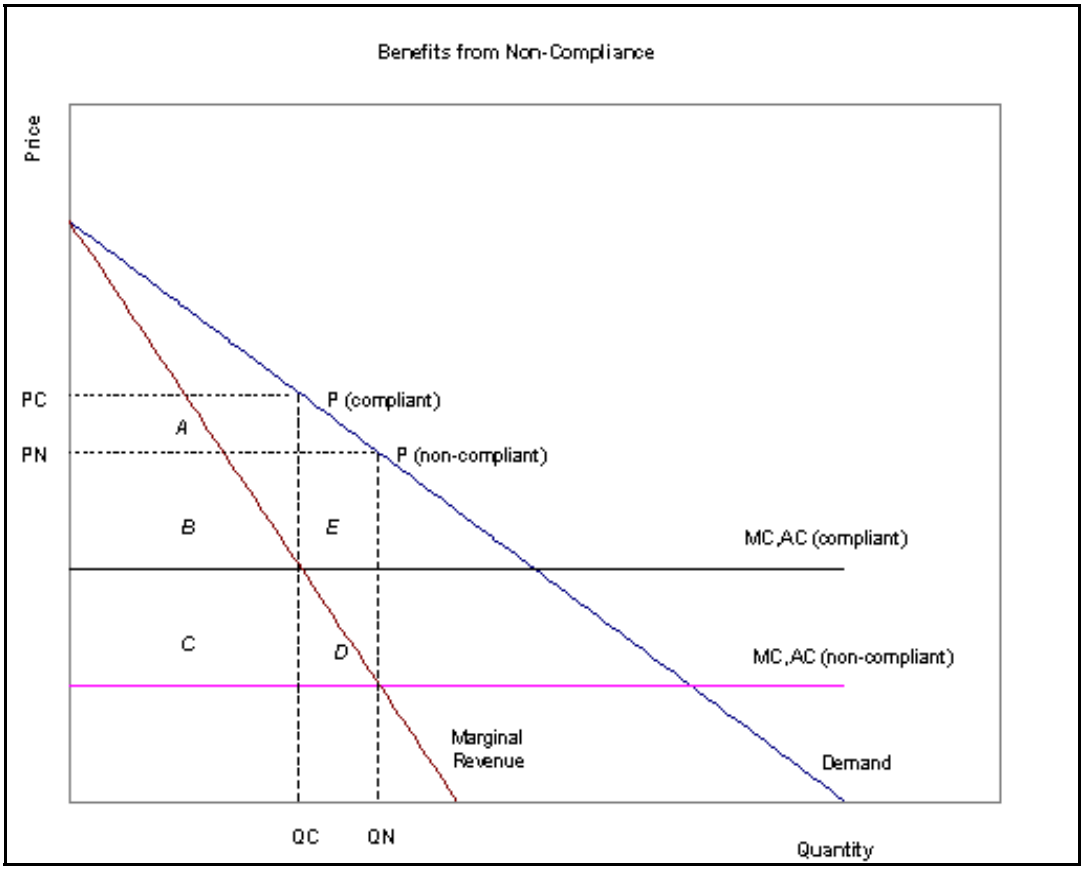

Figure 1 -Benefits from Non-Compliance

There are two situations in which a calculation of economic benefit based on avoided/delayed costs could still be justified. The first is if it can be assumed that the effect on marginal cost and therefore output is sufficiently small that the error induced by ignoring output

effects is also small. The second is if compliance would affect fixed costs only. In that case, compliance would leave marginal cost and, accordingly, output unchanged.

Figure 1 can also be used to analyze cases in which output would be 0 under compliance. Imagine having QC shift to the left until it reaches the axis. (At the same time, PC would move up and reach the intercept of the demand curve.) As QC moves to the left, areas A, B, and C would shrink while D and E would grow. At the point where QC becomes 0, areas A, B, and C disappear, leaving D + E as the measure of economic gain. The sum of those two areas is the company's profits in the non-compliant activity, which at least in principle can be measured directly. This class of cases may well represent the vast majority of cases in which cost savings is not the appropriate measure of economic benefit. It includes those when a firm sells illegal output. It also covers many cases involving illegal development of wetlands.

4.3. Summary

We have now completed enough of our analysis to provide most of our answers to the four charge questions.

1. **Are there categories of cases that would be useful for the Agency to consider in calculating the ICA economic benefit, other than those that are identified in the White Paper? Should any of these be combined?**

We do not think that the categorization offered in the White Paper is particularly useful. In fact we believe that they should be combined into only one category - cases where profits increase at least in part due to increases in revenue.

2. **How can the Agency more accurately characterize the types of cases that are described in the White Paper? Have any of the examples and counter-examples in the White Paper been misidentified with regard to whether they are amenable to the BEN model's simplifying paradigm?**

This is not relevant given our answer to question 1.

3. **Are there any suggestions for modifying the described analytical approach to calculate the economic benefits and;**

We believe that there is no substitute for a careful examination of the facts of each case and the use of methods and data appropriate to each case to estimate the changes in streams of revenue and/or production costs as well as delayed or avoided compliance costs (if any).

4. **The Agency's proposed approach strives to avoid double-counting of the benefit by laying out all relevant cash flows stemming from the violations, as opposed to simply adding on the additional calculations to a BEN run. What additional measures (if any) should the Agency put in place to avoid such potential double-counting?**

Every effort should be made to calculate economic advantage as avoided/delayed costs (and therefore not to decompose the gain into separate components.) One should only resort to a full-blown change in profit analysis when avoided/delayed costs leads to a clearly substantial overestimate of the economic benefit. If it is necessary to do change-in-profit analysis, it is important that the estimate of costs under compliance reflect the lower level of output the firm would have produced rather than the actual production of the polluter.

5. ADDITIONAL ISSUES

5.1. The Effect of Market Structure

As noted, the graphical treatment above (Figure 1) is based on the implicit assumption that the violator is a monopolist or monopolistic competitor. The point that measures of delayed and avoided cost overstate economic benefit applies to competitive markets as well. As with monopoly, this is true even though non-compliance might induce it to produce additional output. The key point is that the cost of coming into compliance at that higher level of output is greater than the profits on the increased sales. (Otherwise, the compliant firm would have also wanted to produce that increased output.)

Whether the point is true in oligopoly is less clear. In the frequently-used Cournot model, avoided and delayed cost on the actual level of output understates the gains companies get from not complying. However, there are other oligopoly models, such as the Bertrand and Stackelberg models, in which avoided and delayed costs overstate the economic benefit from non-compliance, as is the case with monopoly and perfect competition.[3] Cases might arise in which the Agency would want to compute profits from increased sales based on an underlying model of oligopoly. As the appropriate choice among competing models would likely depend on the details of the violator's industry, however, the committee cannot recommend a standard approach. Any estimate of economic gain from non-compliance based on an oligopoly model is likely to be controversial and harder to defend in court than an estimate of avoided or delayed cost. Thus, the EPA should only attempt such estimates when it believes that the profits on increases sales are substantial.

3 Modeling oligopolistic markets raises fundamental issues of economic logic. In general, forcing a firm to pay what it would have cost to comply given its actual level of output leaves it with the profits it would have had if it complied and it chose that same level of output. If it had complied, however, it would not have chosen that output because the profits it generates are lower than it could get with a different output. This logic breaks down in oligopoly models in which firms make incorrect conjectures about the responses of rivals. In the Cournot model, any one firm could make higher profits by increasing its output. A reduction in marginal cost due to non-compliance then induces it to do what it should have done anyway – expand output. The different result for the Bertrand model is because each firm starts by producing too much rather than too little. A marginal cost reduction from non-compliance would cause the firm to produce still more and move to even lower profit levels.

5.2. Dynamic Effects

To this point, we have implicitly assumed that economic benefit from non-compliance arises during the period of non-compliance. There are a variety of reasons, however, why non-compliance could have enduring effects. The violator might gain customers who remain loyal. There might be "learning curve" effects that give it strategic advantages in future periods. It might be involved in an industry in which market saturation takes time. If non-compliance allows it to enter the market earlier than it would have, it might move forward the entire diffusion path.

Also to this point, we have identified two relatively simple ways of estimating economic benefit: avoided/delayed costs on actual quantities is one and profits on all illegal sales is the other, with economic benefit being the lesser of the two.

The presence of dynamic effects does not alter the point that avoided/delayed costs over-estimates economic gains when the polluter increases sales. This point follows from the general logic of optimization. Forcing the firm to pay what it would have cost to comply with regulations at its actual output leaves it as well off as it would have been if it had chosen that output and complied. However, the firm might have done still better by choosing a different (presumably lower) output. Thus, the presence of dynamic effects does not cause avoided/delayed costs to understate economic advantage.

Dynamic effects create more of a problem for profits on increased sales as a measure of economic benefit. If the firm sells more by virtue of not complying and those sales increase future profits, then the value of those future profits is part of the economic gain from non-compliance. A case could arise, for example, in which a company gets an unexpectedly large order from a valued customer. Had it anticipated the order, the company could have made the investments needed to fill the order and comply with environmental regulations. Having not anticipated the order, however, it must either violate environmental regulations or risk losing subsequent business.[4] One might compute the economic gain from the violation as profits on increased sales, but the proper measure would include profits on future sales, the extent and duration of which might be hard to measure. An easier approach might be to determine what it

4 Jasbinder Singh recounted one such case to the panel. In that case, an automobile parts paint company violated environmental regulations while satisfying an unexpectedly large order from Chrysler.

would have cost to bring the plant into compliance for the level of activity that actually occurred. (Even if the notice on the order was so short that it was not physically possible to comply prior to filling the order, one might estimate the economic gain on what compliance would have cost if it did have sufficient notice.)

5.3. Ex Ante vs. Ex Post Assessments

The definition of "economic benefit" used by EPA is fundamentally *ex post.* That is, it asks how much the **realized** economic gain was between the actual noncompliance scenario and the hypothetical compliance situation. An alternative would be to use an *ex ante* definition, under which the appropriate measure would be the economic gain **expected** to be obtained by violating the rule or statute.

To consider which approach, *ex ante* or *ex post*, is most appropriate, it is necessary, first, to consider the goal of the economic benefit assessment. One stated purpose is to recapture the economic benefit that is gained illegally. While this goal fits into a suite of functions that include penalty, fairness, and deterrence, the purpose of the economic benefit component is explicitly said to be to "level the playing field" by removing the (estimated) profits gained by firms through violation. An ex post approach to estimating economic gain in order to recapture the gain appears often sufficient to return the firm to original conditions. There are however, some situations in which *ex post* calculations will fail to achieve EPA's modest goal of "leveling the playing field." In general, these can occur when part of the reason a firm decides to violate involves uncertainty about what value some random variable that affects profits will take.

For example, a pest may infest crops in the region in some years and an illegal pesticide would prevent losses from the infestation. But, in some years the pest does not materialize in the region. If the violation is observed in a year in which the pest does not appear in the region the violation results in no gain, and in fact due to the cost of the pesticide the violation may actually result in a loss. In this case, an *ex post* measure would indicate that no economic gains had occurred.

A second type of situation in which important differences between ex post and ex ante measures might occur is when a firm chooses to violate a statute, at least in part, to reduce its

exposure to risk, which generates an economic benefit to a risk averse firm. While the firm may have enjoyed no change in its average profits over the period of violation, it may nonetheless have received a valuable reduction in risk.

There are many sources of uncertainty that a firm faces in making investment and operating decisions. The choice of whether or not to violate an environmental standard can affect the risks implied by any or all of those decisions on the firm's profitability. For this reason, an ex ante measure is conceptually robust because it accommodates dynamic market events and decision making under uncertainty.

Although an *ex ante* measure of the change in profits may be the preferred measure conceptually, usually an ex post measure of change in profits is the only practical and replicable approach. This is because an *ex ante* measure requires a reconstruction of uncertainty facing the firm at earlier points in time. Therefore, of necessity most enforcement actions will rely on *ex post* assessments of change in profits. It is important that this characteristic of measurement of profits be transparent.

In some cases, the *ex post* approach may be inadequate due to the size of the case and the difference that may occur between ex post and ex ante assessments. When *ex post* is inadequate then analytical support may be necessary to estimate change in profits from an *ex ante* perspective.

5.4. Estimating Compliance Costs - Going Beyond "End-of-Pipe" Technologies

The Agency's approach to calculating delayed or avoided compliance costs is based on the assumption that the firm will comply with the pollution control regulation by adding on some sort of "end-of-pipe" device whose costs depend only on the quantity of residuals being generated and the level of abatement that is sought. In other words, it is assumed that the firm's costs are a separable function of the level of output and the quantity of abatement. This assumption will not always be valid. In the general case, the costs of producing output and the costs of controlling the discharge of pollution are not separable. That is, even in a fairly simple view, the marginal cost of pollution control is a function not just of the extent of control attempted but of changes in production quantity. More generally, the choice of input quality,

product mix from a multiproduct plant, production process design and operating conditions, and of output quality will all have impacts on the marginal costs of controlling pollution discharges to air, water, and solid waste handling facilities. For illustrations of these effects, see (on petroleum refineries) Russell, 1973; and (on integrated steel mills) Russell and Vaughan, 1976.

Looking only at end-of-pipe treatment as the method of complying with a limit on pollution discharge ignores the possibility that adjustments in the production process could have reduced the costs, even if some final treatment remained necessary. Possible adjustments include changes in the types of inputs, reuse and recycling of materials or even changes in the characteristics of the goods or services being produced.

For the EPA's penalty policy, the obvious problem raised by this observation is that getting the cost saving from non-compliance right in principle will require detailed knowledge of the individual facility, its inputs, outputs, and processes. This seems likely to be beyond EPA's ability now and in the future. On the other hand, estimating the costs of an end-of pipe device that could have produced compliance will produce an estimate of delayed or avoided compliance costs that will never be too small. This estimate can be the starting point for negotiations and may be seen as a version of the "presumptive charge", suggested by Eskeland and Devarajan (1996). If a violator wants to contest the penalty thus produced, it would be that firm's responsibility to convince technical reviewers that an alternative combination of production and treatment would have done the same job more cheaply.

6. TOWARD AN OPTIMAL PENALTY POLICY

6.1 Economic Theory of Optimal Penalties

As explained in Section 3.2, the EPA Penalty Policy appears to us to set the goals of fairness and deterrence as primary objectives in the determination of a civil penalty. Here we wish to discuss these objectives, and the larger question of the approach to the determination of a civil penalty, in the light of the economic theory of "optimal" penalty, originally developed by Becker (1968) in the context of criminal punishment, and subsequently elaborated in a large body of economic literature applying the notion to civil penalties as well, including penalties for environmental offenses (see e.g. Cohen, 1992 and 1999).

The economic theory of optimal penalty approaches the issue of deterrence from the perspective of economic efficiency rather than that of fairness. This theory makes two points that are relevant to EPA's penalty policy. The first is based on the assumption that potential offenders respond to both the probability of detection and the severity of punishment if detected and convicted. Thus, deterrence may be enhanced by raising the penalty, by increasing monitoring activities to raise the likelihood that the offender will be caught, or by changing legal rules to increase the probability of conviction. And second, the economically optimal penalty balances the harm done by an offense against the cost of deterring the offense in one or another of these ways. This balancing leads to the conclusion that the appropriate methodology for calculating a penalty is to charge an amount per offense equal to the (monetized) harm done divided by the probability of punishment (see Becker, 1968).

It is worth emphasizing that this optimal penalty is based on the "harm" caused by the offense, not the "gain" to the offender. To take a simple example, if a mugger obtained $100 in a robbery and the victim ended up spending three days in the hospital, a penalty based on the $100 gain to the offender would surely be too low – and would "under-deter" such offenses. In the context of environmental offenses, suppose a firm fails to install a $100 safety valve and as a result 10,000 gallons of crude oil spills into a sensitive coastal area. The $100 "gain" to the offender would certainly not be an appropriate starting point for a penalty. On the other hand, if the savings due to noncompliance were large relative to the harm, a harm-based penalty would not deter noncompliance. But since the gain from noncompliance exceeds the harm,

noncompliance is the economically efficient outcome. Or to put it differently, if regulations are based on a weighing of the benefits and costs, the regulation in question would not have been adopted and the activity would have gone ahead legally.

Alternatively, if the goal is to deter every violation of the law ("absolute deterrence"), then a gains-based penalty is appropriate. We could impose a penalty equal to the gain to the offender divided by the probability of detection and conviction. Then it would never be in the potential offender's interest to violate the law. Some offenses – like violent assaults and rapes – are of this nature (economists sometimes refer to these as "unconditionally deterred" offenses) - society would never condone these offenses regardless of the private benefit to the offender. However, pollution is usually a byproduct of a socially beneficial activity. In the jargon of the law and economics literature, pollution is a "conditionally deterred" offense – one that we only want to prohibit when its social costs exceed its social benefits.[5] If the expected penalty greatly exceeds the expected benefit to the offender and yet the harm from the offense is relatively minor, the result will likely be "over-deterrence." On the other hand, as suggested by the earlier example of 'under-deterring' a mugging offense, and as Polinsky and Shavell (1994) show more generally, an underestimate of gain will make it beneficial to violate the law. Thus, gain-based penalties are more susceptible to under-deterrence than harm-based penalties, because, even if harm is underestimated, the offense is still likely to be deterred if it is very harmful.

Thus, conceptually, the EPA enforcement office should start with an examination of both the harm and the probability of punishment. However, to do so would require relatively good data on both these elements – which are difficult and sometimes impossible to quantify. The next two sections deal with each of the two components of an optimal penalty – harm and probability of detection. Following that, we discuss the current EPA Penalty Policy that focuses primarily on "gain" instead of "harm," and examine what features of that policy might be improved upon.

6.2. Quantifying Harm

If an environmental violation results in emissions levels that are beyond a legal standard, there is likely to be some harm to natural resources or human health. Over the past 40 years, economists have developed a variety of techniques to measure these harms in monetary terms –

[5] We are aware that many of the statutes governing EPA imply the absolute deterrence of polluting activities.

including both revealed preference approaches (e.g. travel cost methodology) and stated preference approaches (e.g. contingent valuation). The field of non-market valuation has emerged as a major branch of environmental economics and there is a very extensive literature on the subject. Measuring people's value for non-market items in monetary terms (e.g., measuring what they would be willing to pay to prevent a specific harm to the natural environment) is inherently difficult, and in practice different measurement techniques can produce different results (this is also true of market valuation). While the methodologies are now well developed and have been used extensively by government agencies for the cost-benefit assessment of public investment projects, the design of public policies, and the assessment of natural resource damages, the methodologies do continue to evolve and there is some continuing disagreement about the relative merits of alternative approaches and their overall reliability.[6] Nevertheless, the Panel believes that the state-of-the-art in benefits estimation has progressed to the point where EPA should seriously explore how it might incorporate "harm-based" measures into its penalty formula, at least for some types of environmental harm. We recognize that while some of the methods used to value environmental harm can be employed with relatively little cost, others require significant resources. Thus, in many (if not the majority of) cases, these methods may not be practical unless the harm (and thus expected penalty) is extremely large. Harm-based measures might only be appropriate for a small number of cases. But these are likely to be the cases that result in very significant and quantifiable harm. Furthermore, since the EPA already makes extensive use of non-market valuation to assess the efficacy of its environmental protection programs and policies, it seems to us appropriate that the Agency should in principle be prepared to apply these same techniques, at least in some cases, to assess the value of the damage when the environmental laws are violated

A possible approach would be to allow for use of "gain to the offender" in cases where harm is not easily quantified and the cost of estimating harm is too great. This approach is similar to that employed by the U.S. Sentencing Commission in determining the default fine tables for organizations convicted of federal crimes (USSC, 2003: Chapter 8 – Sentencing of Organizations). However, they mandate the larger of harm or gain and specifically indicate that if one is hard to estimate, the court may use the other.

[6] For a comprehensive presentation of the methods for valuing changes in environmental conditions, see Freeman (2003). A nontechnical description of methods for valuing changes to ecological systems can be found at http://www.ecosystemvaluation.org.

6.3. Probability of Detection and Punishment

The probability of detection is likely to vary considerably by type of violation and even across jurisdictions. By definition, the probability of punishment is bounded between zero and one. Using the optimal penalty formula, this means that the optimal penalty is bounded by harm and an infinite multiple of harm. Taking the most simplistic case of a very large oil tanker accident, the probability of detection and punishment is likely to be one. Hence, the optimal penalty is simply equal to the harm. This suggests that the optimal penalty for an extremely harmful environmental violation is likely to be the monetary equivalent of harm – without inflating the harm by a multiple. However, as the size of the harm decreases, all else equal, we expect that the likelihood of detection also decreases.

Other factors that might influence the probability of detection and conviction are: (a) whether or not a violator is subject to mandatory reporting that is available to the public to scrutinize and file citizen lawsuits, (b) the ratio of facilities to inspectors in an EPA region, (c) the strength of environmental activism in a region/state, and (d) whether or not the violator had a history of violations and thus was subject to increased scrutiny or targeted enforcement.

In addition to the inherent detectability of certain offenses due to their size, magnitude of harm, or other factors noted above, the offender may take various actions to reduce the likelihood of detection. For example, an oil tanker might clean its tanks at sea to evade detection by the Coast Guard. A firm that fails to meet permit standards might falsify mandatory reporting records. Inspectors might be bribed or their attention diverted with false emergencies or false leads. While these hypothetical examples are not exhaustive, they illustrate that the EPA (and/or the Court) might ultimately determine that actions were taken to reduce the chance of being caught or prosecuted. Those actions would lead to lower detection probabilities and hence higher penalties under the optimal penalty framework.

Although not widely employed in the environmental literature to date, numerous techniques are available to estimate the probability of detection and punishment – depending upon the circumstances. For a detailed discussion of this issue, see Parker (1989: 578-81). One widely used method is the “time till capture” approach which is most appropriate for ongoing violations that occur over a period of time. Nash (1991) used this approach to estimate the probability of detection for four types of fraud violations enforced by the Federal Trade Commission – violations of FTC orders, violations of FTC regulatory standards, Truth-in-

Lending case, and unfair business practices. Nash concluded that the appropriate multiple for this type of regulatory violation is approximately 4.0, indicating that the penalty should be four times the harm.

Another method - the "capture/recapture" approach has its foundation in estimating the number of animals in a given geographic area. When there are multiple sources of detection (e.g. government inspectors as well as private citizens monitoring self-report data), one can exploit the fact that there is some overlap between these multiple sources. By examining how many different offenses are observed between the two "inspectors" and how many are identical, one can estimate the total number of offenders in the population. For example, Froehlich and Bellantoni (1981) estimated the probability of detection for oil spills greater than 10,000 gallons was 0.87, based on the combination of two independent sources of information. Cohen (1987: 44-5) combined this with Coast Guard data indicating that they can identify the source of about 70 percent of spills that are detected, to arrive at an overall probability of detection of 60 percent.

6.4. Implications for Current EPA Policy

As discussed earlier, the current EPA Penalty Policy starts with the calculation of "gain" – i.e. estimating the amount that the offender saved by not complying with environmental regulations, and then adds a "gravity" component based in part on the harm from the offense. However, the policy does not provide for quantifying the "harm" and also ignores any explicit consideration of the probability of detection.

Thus, an alternative approach that might be explored by EPA would be to provide for a "base" fine that is predicated on the harm. If harm cannot be quantified, the base might either be "gain" or a "default" fine level that is specified by type of offense. This base fine would then be multiplied by a factor that is based on the probability of detection.[7]

EPA's civil penalty policy currently incorporates a few features that might proxy for the probability of detection and conviction. Specific gravity components are (EPA, 1984: 14-15);

[7] This is similar to the approach taken by the U.S. Sentencing Commission (2003). Also see U.S. Sentencing Commission (1988) for draft guidelines for sentencing organizations that more explicitly identify harm and probability of detection as the controlling factors.

(1) Importance of the regulatory scheme – The policy indicates that violations that are more important to the regulatory scheme will receive higher penalties. The example given suggests that more important violations will be harder to detect in many situation. Thus, the fact that no warning label is contained on a product would be more important than a warning label that was simply too small. The existence of the small warning label makes detection easy – since the product has already been identified as being hazardous. Whether or not this one example is illustrative and other cases are related to the detection probability is unclear.

(2) Availability of data from other sources – If a record keeping or reporting requirement is violated and that is the only source of information, the probability of detection is much lower than if multiple sources of the same data are available elsewhere. Thus, this gravity component appears to be consistent with increasing the penalty when the likelihood of detection is smaller.

(3) Size of violator – The policy allows for increasing the penalty when the violator is particularly large and the size of the penalty will otherwise unlikely be large enough to get the violator to take notice. It is not clear what this has to do with the probability of detection.

Importantly, the policy also contains a provision that addresses the "general deterrent" effect of the calculated gravity component of the penalty (EPA, 1984: 16). This provision states that in some cases, "the normal gravity calculation may be insufficient to effect general deterrence. This could happen if there was extensive noncompliance with certain regulatory programs in specific areas of the United States. This would demonstrate that the normal penalty assessment had not been achieving general deterrence." Thus, even though there is no guidance on a proper multiple, there appears to be some understanding that detection probability needs to be taken into account. The Panel recommends that EPA begin to study the feasibility of formalizing these concepts and providing more explicit guidance on how to calculate penalties that take into account both the harm and probability of detection.

APPENDIX A - A MORE DETAILED DESCRIPTION OF THE SAB PROCESS AND PANEL REVIEW PROCEDURES

This Appendix identifies process of Panel selection and formation.

A.1 Request for Review and Acceptance

In June 2002, the Office of Enforcement and Compliance Assurance (OECA) had requested that the Science Advisory Board review the OECA White Paper. After considering all requests for 2004, the Science Advisory Board determined that the review should be conducted by a specialized panel. The Director of the Science Advisory Board Staff Office, in consultation with the Chairman of the Science Advisory Board, selected SAB member Dr. A. Myrick Freeman of Bowdoin College, as chair of the Illegal Competitive Advantage (ICA) Economic Benefit (EB) Advisory Panel.

A.2 Panel Formation

The panel was formed in accordance with the principles set out in the 2002 commentary of the Science Advisory Board, *Panel Formation Process: Immediate Steps to Improve Policies and Procedures* (EPA-SAB-EC-COM-02-003). A notice offering the public the opportunity to nominate qualified individuals for service on the panel was published in the Federal Register on August 6, 2003 (68 FR 46604) soliciting nominations for Panel membership and can be found on the SAB Web site at: http://www.epa.gov/sab, Eleven individuals were considered for membership on the panel. On the basis of candidates' qualifications, interest, and availability, the SAB Staff Office made the decision to put 11 candidates on the "short list" for the panel. On March 26, 2004, the SAB Staff Office posted a notice on the SAB Web site inviting public comments on the prospective candidates for the panel.

The SAB Staff Office Director — in consultation with SAB Staff (including the Designated Federal Officer (DFO) and the Acting SAB Ethics Advisor) and the Chair of the Executive Committee — selected the final panel. Selection criteria included: excellent

qualifications in terms of scientific and technical expertise; the need to maintain a balance with respect to qualifying expertise, background and perspectives; willingness to serve and availability to meet during the proposed time periods; and the candidates prior involvement with the topic under consideration. The final panel includes persons with expertise in one on more of the following areas:

(a) Financial Economics, which includes Corporate Finance,
(b) Economic Benefit recapture Issues,
(c) Business/Commercial Damages, which includes Anti-trust Law, Torts, and Economics,
(d) Business Economics and Competitive Strategy, which includes aspects of Statistical Decision-Making and Game Theory, as well as Competitive Effects of Vertical Integration and Quantitative Economics, and
(e) Industrial Organization, in the context of environmental regulations, and their enforcement, as well as Environmental and Regulatory Economics, Environmental Ethics and Sustainability in this context.

The Panel members include individuals who are SAB members or consultants familiar with the Agency as well as first-time consultants. The final panel determination memo was posted on July 9, 2004.

A.3 Panel Process and Review Documents

The Panel first met via conference call on July 12, 2004. The purpose of this public conference call meeting was to provide background information for the Panelists on the issues in preparation for the advisory activity. The Panelists a) discussed the charge, review and background materials provided to the Panel, b) discussed specific charge assignments for the Panelists, and c) advised the Office of Enforcement and Compliance Assurance (OECA) of any specific points that need clarification for the August 5 & 6 advisory meeting. Two Panelists were unable to attend this initial conference call meeting.

August 5-6, 2004 face-to-face meeting was held in Washington, DC. This also was a public meeting, and as in the teleconference call, an opportunity was provided for public

comments pursuant to and consistent with the requirements of the Federal Advisory Committee Act (Public Law 92-463. All but one of the panelists were present at the August 5 & 6, 2004 meeting. The one unable to attend the Washington meeting was available via conference call hookup.

Follow-up conference calls were held on September 22, and November 4, 2004 to prepare and complete edits to the draft Advisory. (More details to follow, as this unfolds - - - - KJK)

APPENDIX B - BRIEF BIOSKETCHES OF THE ILLEGAL COMPETITIVE ADVANTAGE (ICA) ECONOMIC BENEFIT (EB) ADVISORY PANEL

Dr. Dallas Burtraw:

Dr. Burtraw is a Senior Fellow at Resources for the Future. He recently served on the National Research Council, Committee on Air Quality Management in the United States and serves as a reviewer, National Energy Modeling System, Energy Information Administration, (1992-present). Dr. Burtraw's areas of expertise include: air pollution, cost-benefit analysis, electricity restructuring, regulatory design, and public finance. His research interests include the restructuring of the electric utility market, the social costs of environmental pollution, benefit-cost analyses of environmental regulation, and the design of incentive-based environmental policies. His current projects include the study of integrated approaches to pollutant control in the electricity sector and the valuation of natural resource improvements in the Adirondacks. Recently, Dr. Burtraw analyzed the cost-effectiveness of various designs for NO_2 emission trading in the eastern states and of the design for a carbon emission trading program in the electricity sector. He also investigated the effects on electric utilities of the sulfur dioxide emissions-permit trading program legislated under the 1990 Amendments to the Clean Air Act, and evaluated the benefits of emission reductions resulting from the 1990 Amendments. He holds a Ph.D. in Economics and a Master in Public Policy from the University of Michigan.

Dr. Mark Cohen:

Professor Cohen is Senior Associate Dean and Justin Potter Professor of American Competitive Business at the Owen Graduate School of Management at Vanderbilt University. He also serves as Co-Director of the Vanderbilt Center for Environmental Management Studies, and as Visiting

Professor of Criminal Justice Economics at the University of York (UK). He recently served as Chairman of the American Statistical Association's Committee on Law and Justice Statistics and is currently a member of the Stakeholder Council of the Global Reporting Initiative. Prior to his position at Vanderbilt, he had served as senior economist with the U.S. Sentencing Commission. His work experiences include the Federal Trade Commission, the U.S. Environmental Protection Agency, the U.S. Department of the Treasury, and the U.S. Senate Banking Committee. He received his B.S.F.S. in International Economics from Georgetown University, and his M.A. and Ph.D. in Economics from Carnegie-Mellon University. Professor Cohen has published over 70 articles on diverse topics such as enforcement of government regulation, law and economics, white-collar and corporate crime, and environmental management. Some of his prior work related to the proposed panel include: the costs and benefits of oil spill enforcement policies; analysis of EPA's penalty policy; optimal penalties for corporate crime including environmental and antitrust offenses; the public's willingness-to-pay for crime control policies; why firms comply (and overcomply) with environmental regulations; does it "pay" to be green; and the effect of disclosure on environmental performance. Research grants over the past few years include "Measuring Public Perception of Appropriate Prison Sentences"

(National Institute of Justice, 1999) and "Does It Pay to be Green? The Relationship between Environmental and Financial Performance" (W. Alton Jones Foundation, 1996). In addition he has recently served as a consultant to two different research projects on corporate environmental

performance: (1) University of Kansas, funded by EPA, and (2)University of Maryland, funded by NIJ.

Dr. A. Myrick Freeman:

Myrick Freeman III is Research Professor of Economics at Bowdoin College. In 2000 he retired from teaching after 35 years. Dr. Freeman received his Ph.D. in economics from the University of Washington in 1965. He has been on the faculty at Bowdoin since that time and has served as chair of the economics department and Director of the Environmental Studies Program there. He has also held appointments as Visiting College Professor at the University of Washington and Robert M. La Follette Distinguished Visiting Professor at the University of Wisconsin-Madison and as a Senior Fellow at Resources for the Future, a research organization in Washington, DC.

Dr. Freeman's principal research interests are in the areas of applied welfare economics, benefit-cost analysis, and risk management as applied to environmental and resource management issues. Much of his work has been devoted to the development of models and techniques for estimating the welfare effects of environmental changes such as the benefits of controlling pollution and the damages to natural resources due to releases of chemicals into the environment. He has authored or co-authored eight books including Air and Water Pollution Control: A Benefit-Cost Assessment, and The Measurement of Environmental and Resource Values: Theory and Methods, now in its second edition. He has also published more than 70 articles and papers in academic journals and edited collections. Dr. Freeman has been a member of the Board on Toxicology and Environmental Health Hazards of the National Academy of Sciences and has served as a member of the Advisory Council on Clean Air Compliance Analysis, the Clean Air Science Advisory Committee and the Environmental Economics Advisory Committee of the U.S. Environmental Protection Agency Science Advisory Board. Most recently, he chaired the EPA SAB Review Panel on UST/RCRA Benefits, Costs, and Impacts Assessment.

Dr. Jane V. Hall

Dr. Jane V. Hall is Professor of Economics in the College of Business and Economics and Co-Director of the Institute for Economic and Environmental Studies at California State University, Fullerton. Her current research areas are assessing the value of environmental protection, economics of air pollution policy, natural resource scarcity, and environmental resource scarcity and conflict. She has lectured and conducted research on the topics of energy, sustainability, resource scarcity and conflict, benefit assessment, economic performance and environmental regulation, economic incentives for environmental management and related topics. She has developed positions on air quality standards, fuel composition and taxation, energy policy as an Associate Staff Scientist with the Environmental Defense Fund and as a Special Advisor to the Chair of the California Air Resources Board, and Deputy Assistant for Environmental Protection to the Governor of California. She has also served as an economist with Unocal (Union Oil Company) to assess the impact of federal and state energy policies on the economy and the energy industry. She has published over 100 articles, books or book chapters, working papers and presentations on the above topics. She has served as a member of the Advisory Council on Clean Air Compliance Analysis (COUNCIL), and its Health and Ecological Effects Subcommittee, the EPA's Children's Health Protection Advisory Committee, and a number of other advisory and scientific bodies. She has served as a reviewer for the National Science Foundation, California Air Resources Board Research Division, and for the following publications: *Contemporary Economics Policy, Ecological Economics, Environmental Science and Technology, the Journal of Economics and Environmental Management, the Journal of Environment and Development, and the National Science Foundation's Science Journal*. Dr. Hall received her B.A. in Economics from the University of Washington, her M.S. in Agricultural and Resource Economics and her Ph.D. in Energy and Resources from the University of California at Berkeley.

During the past five years, Dr. Hall has had research funding from the California Air Resources Board (A Pilot Study to Quantify Health Benefits of Incremental Improvements in Air Quality; Economic Valuation of Ozone-Related School Absences in the South Coast Air Basin; and Innovative Clean Air Technology Assessment), the W. Alton Jones Foundation (Growth for health: the Zero Emission Vehicle and California's Future Prosperity), Sea Grant/NOAA (Economic Valuation of the Rocky Intertidal Zone), and the U.S. Environmental Protection Agency and City of Houston (Valuation of Air Pollution and Health).

Dr. W. Michael Hanemann:

Dr. W. Michael Hanemann is Chancellor's Professor in the Department of Agricultural and Resource Economics and Goldman School of Public Policy at the University of California, Berkeley. He is Director of the California Climate Change Center at UC Berkeley. Dr. Hanemann's research interests include non-market valuation, environmental economics and policy, water pricing and management, demand modeling for market research and policy design, the economics of climate change, the economics of irreversibility and adaptive management, and welfare economics. Dr. Hanemann's recent publications have addressed the economic impact of climate change on US agriculture, fishery management under multiple uncertainty, non-market valuation using the contingent valuation method, the economic value of reducing asthma, and the economic theory of willingness to pay and willingness to accept.

Dr. Hanemann was educated at Oxford University (B.A.), the London School of Economics (M. Sc.), Harvard University, (M.A. in Public Finance and Decision Theory and Harvard University (Ph.D. in Economics). Last October, he was awarded an Honorary Ph.D. by the Swedish University of Agricultural Sciences. Dr. Hanemann is a member of the California Bay-Delta Authority Drinking Water Advisory Committee. He served as Chair of the Organizing Committee for the Second World Congress of Environmental and Resource Economists, held in Monterey CA in June 2002. In the past 5 years, Dr. Hanemann has received research funding from the US EPA STAR Grant Program (economic value of childhood asthma, embedding in contingent valuation); NSF (price and non-price tools for water conservation), NOAA, MMS, the California State Water Resources Control Board and The California Department of Fish & Game (economic value of beach recreation in Southern California), and the California Energy Commission (climate change policy in California).

Dr. Catherine L. Kling:

Dr. Kling is a Professor of Economics at Iowa State University (ISU) and Head of the Resource and Environmental Policy Division of the Center for Agricultural and Rural Development at ISU. Prior to coming to Iowa State University in 1993, she was an Associate and Assistant Professor in the Department of Agricultural Economics at the University of California, Davis. She has taught graduate and undergraduate courses in environmental economics, microeconomic theory, and econometrics. Dr. Kling's research encompasses nonmarket valuation issues in environmental economics and economic incentives for pollution control related especially to agricultural problems. Her research has been published in a variety of economics journals including *The Review of Economics and Statistics, Journal of Public Economics, Journal of Environmental Economics and Management, American Journal of Agricultural Economics, Land Economics, Environmental and Resource Economics,* and *Ecological Economics*.

Dr. Kling has also served the profession and the public sector in a variety of capacities including her current membership on EPA's Environmental Economics Advisory Committee to the Science Advisory Board. Current and past service includes as a member of the board of directors and awards committee chair for the American Agricultural Economics Association,

vice president and member of the board of directors of the Association of Environmental and Resource Economists, associate editor for the *American Journal of Agricultural Economics,* and the *Journal of Environmental Economics and Management*, as well as numerous *ad hoc* committees for the AAEA, AERE, and other professional associations. Dr. Kling's research support has been provided through grants from the Iowa Department of Natural Resources, the U.S. Environmental Protection Agency, the U.S. Department of Agriculture, the California Institute for Energy Efficiency, the Giannini Foundation, and the Sloan Foundation. Dr. Kling holds a B.A. in Business and Economics from the University of Iowa, and a Ph.D. in Economics from the University of Maryland.

Dr. Arik Levinson:

Dr. Levinson is an Associate Professor in the Economics Department of Georgetown University, where he teaches environmental economics, public finance, and microeconomics, and is Director of Undergraduate Economic Studies. He is a Faculty Research Fellow at the National Bureau of Economic Research, is on the Editorial Council of the Journal of Environmental Economics and Management, and is a member of the American Economic Association, the Association of Environmental and Resource Economists, and the Association for Public Policy Analysis and Management. Professor Levinson's research interests include the fields of public finance and environmental economics. He has studied the theoretical welfare consequences of states competing to attract manufacturers by enacting successively less stringent environmental standards (a "race to the bottom"), and measured empirically the effects of interstate differences in environmental standard stringency on manufacturer location decisions, trade, employment, and foreign direct investment. Recently, he has written theoretical and empirical papers on the relationship between countries' environmental quality and their incomes. He has studied the energy efficiency consequences of apartment leases that include monthly utility costs, and he has written about the relationship between individuals' willingness to pay for environmental quality, household income, and national income. His research has in part been funded by the National Science Foundation, and by the Association for Public Policy Analysis and Management. Dr. Levinson holds a Ph.D. in Economics from Columbia University.

Dr. Clifford S. Russell:

Dr. Clifford S. Russell is Professor of Economics, Emeritus, Vanderbilt University; and Research Associate, Bowdoin College. He joined the Vanderbilt faculty as professor of economics and director of the Institute for Public Policy Studies in January, 1986. Before coming to Vanderbilt, Dr. Russell was a Senior Fellow and director of the Environmental Quality Research Division at Resources for the Future in Washington, D.C. During his 17-year tenure there, he held several other leadership positions. He is the author and editor of 16 books and author or co-author of 68 articles in environmental economics. His major current interest is in the systematic examination of environmental labeling as a tool of environmental policy. Dr. Russell has served as a member of several National Academy of Science committees, and on the Environmental Studies Board. In 1992/93 he chaired an NAS panel evaluating the U.S. Department of Energy's proposed system for setting clean-up priorities at contaminated nuclear weapons and research facilities. He was President of the Association of Environmental and Resource Economists in 1993 and 1994. From December, 1996, to August, 1997, he held the Valfrid Paulsson visiting chair in environmental economics at the Beijer Institute, part of the Royal Swedish Academy of Sciences in Stockholm. In 2003 he held the Robert Sowell Distinguished Visiting Chair of Economics at Bates College. In the 1970s and ‘80s Dr. Russell was on the Executive Committee of the Board of the Environmental Defense Fund (now Environmental Defense). He also served on the board of the Tennessee Environmental Council. Dr. Russell received his B.A. in mathematics from Dartmouth College and his Ph.D. from

Harvard University, where he was a Harvard Graduate Prize Fellow in Economics. From 1960 through 1963, he served as a commissioned officer in the U.S. Navy.

Dr. Michael A. Salinger:

Dr. Salinger is Professor of Economics and Chairman of the Finance and Economics Department at the Boston University School of Management. He served as an economist in the Bureau of Economics in the Antitrust Division with the United States Federal Trade Commission while on leave from Columbia University. At Columbia University, he served as Associate Professor of Economics and Finance. He also was a Visiting Associate Professor of Economics at MIT's Sloan School of Management. Dr. Salinger is on the Editorial Boards of the *Journal of Industrial Economics, and Review of Industrial Organization.* He has published on such topics as the relationship between market structure and corporate profitability, the competitive effects of business practices (including vertical mergers and bundling), the statistical properties of firm growth, antitrust policy, and the regulation of telecommunication prices. His recent research has been funded by the National Science Foundation and by Microsoft. He has served as a peer reviewer of the BEN model for the EPA. He received his B.A. in Economics form Yale University and his Ph.D. in Economics from Massachusetts Institute of Technology.

Dr. David Sunding:

David Sunding is a professor at the University of California at Berkeley in both the College of Natural Resources and the Boalt Hall School of Law. He received a B.A. in Economics from Claremont McKenna College in 1983 and his Ph.D. in Agricultural and Resource Economics from the University of California at Berkeley in 1989. He specializes in environmental policy, natural resource economics, land use, and law and economics. Prior to his current position, Prof. Sunding served as a senior economist at the President's Council of Economic Advisers where he had responsibility for natural resource and environmental policy. He currently serves as member of the Science Advisory Board of the National Center for Housing and the Environment and is the co-director of UC Berkeley's Center for Sustainable Resource Development.

Professor Sunding is the author of over 50 journal articles and book chapters in the areas of environmental economics, natural resource economics, and law and economics. He has been commissioned to write over 30 technical reports and monographs for government and private interests. Recently, Professor Sunding's research has focused on the measurement of environmental compliance costs, environmental regulation and processes of urban growth and development, and the diffusion of conservation technology. Dr. Sunding has had extensive litigation experience in the areas of compliance cost measurement, environmental remediation and cost allocation, antitrust and unfair competition, and agricultural and natural resource markets. He has performed economic and financial analysis relating to damage calculations, market determination, real property valuation, antitrust and price discrimination and has testified at deposition and trial. He has recently received grants and/or research funding from the U.S. Environmental Protection Agency, Food Systems Research Group, California Department of Food and Agriculture, California Department of Water Resources and U.S. Department of the Interior.

APPENDIX - C ACRONYMS

AAEA	American Agricultural Economics Association
ADV	Advisory
AERE	Association of Environmental Resource Economists
ALJ	Administrative Law Judges (of the U.S. EPA)
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CFR	Code of Federal Regulations
COM	Commentary
CWA	Clean Water Act
DFO	Designated Federal Officer
DOI	Department of the Interior (U.S. DOI)
EB	Economic Benefit
EC	Executive Committee (of the U.S. EPA/SAB)
EEAC	Environmental Economics Advisory Committee (of the U.S. EPA/SAB)
EPA	Environmental Protection Agency (U.S. EPA)
FR	Federal Register
ICA	Illegal Competitive Advantage
LLC	Limited Liability Corporation
NIJ	National Institute of Justice (? - see last line of Dr. Mark Cohen's Biosketch in Appendix B - - - KJK)
NOAA	National Oceanic and Atmospheric Administration (U.S. NOAA)
OECA	Office of Enforcement and Compliance Assurance (of the U.S. EPA/OECA)
OECM	Office of Enforcement and Compliance Monitoring

QRS	Quality Review Subcommittee (of the U.S. EPA/SAB)
PC	Price-Compliant
PN	Price Non-Compliant
QC	Quantity-Compliant
QN	Quantity Non–Compliant
SAB	Science Advisory Board (of the U.S. EPA/SAB)
USSC	United States Statutory Code
U.S.	United States

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