Good morning Chairman Lloyd and members of the Board.

A number of investigators have reported that daily variations in ambient particulate air pollution have been associated with cardiovascular disease and deaths. The Air Resources Board has very recently adopted annual PM 10 and PM 2.5 standards and continues to review the latest information to protect the most sensitive members of the public from chronic and acute health effects, including those with cardiovascular disease.

The presentation this morning is a discussion of a preliminary study of subjects with coronary heart disease who were monitored with a standard electronic cardiac test. The test results were compared with airborne concentrations of ultrafine and fine particulate matter, and other air pollutants.
In previous research, investigators have demonstrated that daily exposure to ambient fine particles (< PM2.5) are associated with cardiovascular disease and mortality.

The biological mechanisms of how PM 2.5 may cause cardiovascular disease and mortality are unknown, and...

The physical and chemical properties of PM that are potentially responsible for its toxicity are also unknown.

Investigators have reported that ultrafine particles (those less than 0.1 micrometer diameter) have been associated with respiratory health effects. However, there is little information on the association between exposure to ultrafine particles and cardiovascular health.

The research discussed today is an initial study on exposure to PM, including ultrafine PM, and their association with any specific cardiovascular health effects.
The research that we will be discussing this morning is entitled, Particulate Air Pollution and Risk of ST-Segment Depression Among Subjects with Coronary Heart Disease by Dr. J. Pekkanen and colleagues from the Unit of Epidemiology, National Public Health Institute, Finland. The study was recently published in the medical journal “Circulation”.

The research involved evaluating cardiovascular health effects of PM in patients with coronary heart disease. There were 45 adult men and women studied. Exercise tests were conducted every 2 weeks for 6 months.

The approach used by the investigators to evaluate cardiovascular effects was to examine electrocardiogram, or ECG patterns, and relate the results of any ECG changes with exposure to airborne particulate matter and other air pollutants.

The next slide is an illustration of a normal and abnormal ECG and summarizes the results of the study.
Results

- Found an association of ST-depression with exposure to fine and ultrafine PM
- Also found association with CO and NO$_2$, but not with coarse PM

The electrocardiogram represents electric signals emitted by the heart for essential normal function. A normal ECG pattern representing a single heart beat is illustrated in the upper figure.

The specific abnormal ECG pattern observed for the study discussed is called an “ST segment depression”. This abnormal pattern may be an indicator of an adverse health effect taking place in the heart, namely a high probability of myocardial ischemia, or lack of oxygen to the heart muscle.

The lack of oxygen, in turn, results in a higher risk of heart damage and acute myocardial infarction, or heart attack. An abnormal ECG representing an ST Segment Depression is illustrated in the lower figure. Note that the ST portion of the electrical signal (shown in the circle) is lower than that seen in the Normal signal.

The authors reported that there was an association between fine PM as well as ultrafine PM exposure and the risk of exercise-induced ST-segment depression, and that association was most significant 2 days after exposure. The risk was significantly elevated approximately 3 times what was normally expected. The association of ST depression with ultrafine PM was independent of fine PM.

Carbon Monoxide and Nitrogen Dioxide were associated with the ST segment depression, but these associations were weaker. There was no consistent association for coarse particles.
Conclusions and Implications

- Myocardial ischemia (lack of oxygen) may be part of the mechanism of toxicity for fine and ultrafine PM
- Plausible biological link between fine or ultrafine PM and cardiovascular health effect needs verification
- Meeting clean air standards can result in a significant improvement in cardiovascular health

This pilot study supports the finding that fine PM is associated with cardiovascular health effects. It is one of the first studies regarding ultrafine PM exposure and cardiovascular health effects.

Although this study is considered preliminary regarding the mechanism of fine and ultrafine PM and its effects on the cardiovascular system, it provides insight for developing and testing future hypotheses. That is, fine and ultrafine PM may cause a higher risk of cardiac ischemia, a serious health effect.

Further, verification of this type of study is needed in larger populations, in a variety of cities, and with different mixtures of air pollutants.

Finally, the paper summarized today may help in the effort to focus future research and to review ambient air quality standards, and implies that meeting clean air quality standards can result in significant improvement in cardiovascular health.

This concludes the health update and we would be happy to answer any questions.

Thank you very much.