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UNITED STATES DISTRICT COURT

NORTHERN DISTRICT OF CALIFORNIA – SAN FRANCISCO DIVISION

UNITED STATES OF AMERICA, Plaintiff, v. AU OPTRONICS CORPORATION, et al., Defendants.	Case No. CR-09-0110 (SI) **DECLARATION OF JOSEPH KADANE, Ph.D., IN SUPPORT OF AUO DEFENDANTS' MOTION IN LIMINE TO EXCLUDE OVERCHARGE TESTIMONY OF PROPOSED EXPERT KEITH LEFFLER, Ph.D.** Date: February 13, 2012 Time: 8:30 a.m. Judge: Hon. Susan Illston Place: Courtroom 10, 19th Floor

I, Joseph B. Kadane, Ph.D., declare and say as follows:

1. I am over the age of 18 years and make this declaration based on first hand knowledge and, if called upon to do so, I could testify to the matters stated therein.

A. Qualifications and Assignment

2. I was awarded a Ph.D. in Statistics by Stanford University in 1966 and have worked in the field of statistical science for nearly 50 years. Since 1985, I have been the Leonard J. Savage Professor of Statistics and Social Sciences at Carnegie Mellon University. I took University Emeritus status in 2006. **Exhibit A** attached hereto lists the cases in which I have offered testimony and/or depositions in the last four years. Additional information about my education, qualifications and experience as an expert in the field of statistics are set forth in my *curriculum vitae*, a copy of which is attached hereto as **Exhibit B**.

3. Counsel for AU Optronics asked me to review the September 13, 2011 report ("Report") of Professor Keith Leffler prepared in connection with this matter, as well as Dr. Leffler's supplemental disclosures dated January 9, 2012 and January 29, 2012. I have reviewed all three documents. Table 12 of Dr. Leffler's Report sets forth the overcharge results of various regression analyses and he explains (at Paragraph 52 of his Report) that the "best estimate" of overcharge if $439 per square meter. Significantly, Table 12 reports that the standard error associated with that result is $272.32. Dr. Leffler uses the $439 overcharge amount to compute the total overcharge caused by the alleged conspiracy ($12.3 billion in his original Report, revised to $6.9 billion overcharge to U.S. commerce in his January 9, 2012 supplement). I have been asked to comment, from the perspective of statistical science, on the reliability of the regression results that Professor Leffler uses to compute the loss allegedly caused by the conduct at issue.

4. To provide some context, I will first explain some of the statistical terms and concepts used in Dr. Leffler's Report and discussed in this declaration. I will then explain why Dr. Leffler's estimated overcharge of $439 is not statistically significant, and therefore not reliable, according to well-established standards of statistical science. Because Dr. Leffler's Report is written from the perspective of classical, sampling theory of statistics, I will use terminology consistent with that theory in this

declaration.

B. Placing Dr. Leffler's Overcharge Result in its Statistical Context

5. Dr. Leffler's overcharge estimates are the results of a regression analysis or a regression model. A regression is a common mathematical technique used by statisticians, economists and other social scientists to evaluate—or, more technically, to "estimate"—the relationship between one variable (called the dependent variable) and a selected set of input variables. Put more simply, Dr. Leffler uses regression analyses in this case to estimate the effect, if any, between Crystal Meetings at which prices for TFT LCD panels were allegedly discussed and the actual prices of TFT LCD panels. (The regression uses other input variables as measures for supply and demand factors, but the focus of his inquiry is to estimate the effect that discussing prices at those meetings had on actual prices.) A regression analysis, if properly performed and evaluated, can be a useful tool for this type of inquiry.

6. Consistent with other scientific inquiries, statisticians and economists who perform regression analyses typically begin with a "null hypothesis," *viz*., an assumption that the dependent variable has no relationship to and is not affected by input variables. Mathematically, that null hypothesis is expressed as a coefficient of "zero" multiplying the variable of interest. The null hypothesis is considered rejected if the regression yields an estimate that departs from zero and that is statistically significant, thus supporting the conclusion that the input variable in question does, in fact, have an effect on the dependent variable. To put this another way, one uses a regression to test a null hypothesis by assuming, in the first instance, that a particular regression coefficient has the value zero; one defines a test statistic and computes the probability that data as or more extreme than those observed would be observed were the null hypothesis true.

7. Computer statistical software used to run regression analyses will typically report an estimate, or coefficient, for the dependent variable and will also report a "standard error" for that variable. In the case of linear regression results, the standard error is used to determine whether the coefficient is statistically different from zero, which is necessary to reject the null hypothesis. Thus, typically, one divides the coefficient by the standard error, and the resulting ratio is the "t-statistic."[1] In

[1] This ratio is called a t-statistic because its distribution under the null hypothesis has a student-t distribution. Student-t distributions are governed by their degrees of freedom, which is roughly the number of data points

this case for instance, Dr. Leffler's regression yielded an overcharge coefficient, or estimate, of $439 per square meter and a standard error of $272. Dividing the coefficient by its standard error results in a t-statistic of 1.61 (439/272.32 = 1.61). Therefore, the model's estimate of $439 is 1.61 standard deviations away from zero (which is the null hypothesis).

8. Another way to mathematically express the measure of confidence in a regression result is through the use of a "confidence interval." As explained further below, the confidence interval of 95% is generally accepted as the standard of reliability. The 95% confidence level corresponds to 1.96 standard deviations, assuming a "two-tailed test."[2] It is also possible to calculate the range of the confidence interval. Using the amounts here, one multiplies the standard error of $272.32 by 1.96, which equals $534. Deducting and adding that amount to the reported coefficient of $439 means that, for Dr. Leffler's result, no null hypotheses between ***minus*** $95 and $928 would have been rejected at the 5 percent level. Therefore, Dr. Leffler's regression does not reliably reject the existence of any hypothetical coefficient within this range, be it overcharge, no effect or undercharge

C. Dr. Leffler's Overcharge Result is Not Statistically Significant

9. I now turn to the issue of the reliability of Dr. Leffler's estimate of a $439 overcharge per square meter.

10. It is widely accepted as a matter of statistical science and in the social sciences more

minus the number of parameters. I write "roughly" because adjustments would have to be made for the fact that in the regressions here a simultaneous regression model was fit using two-stage least squares and because of the use of the Newey-West autocorrelation procedure. The exact number of degrees of freedom does not have to be computed in this instance because the t-distribution is well approximated by the familiar normal distribution, with its bell-shaped curve. Using this approximation slightly overstates the level of significance obtained by Dr. Leffler, because findings that might be significant under the normal distribution might not be under a t-distribution with a finite number of "degrees of freedom", which depend upon the number of observations and other factors. Nonetheless, the approximation, while conservative, is quite accurate enough for our purposes.

[2] In a two-tailed test, the null hypothesis is tested against a more general alternative that the null hypothesis is false (either because the regression coefficient is truly positive or truly negative). For the type of analysis Dr. Leffler has performed, the preferred method is to use a two-tailed test and I assume he has done so (although his Report is silent on this point). On the other hand, in a one-tailed test, the null hypothesis is tested for example against the alternative that it is positive. If, Dr. Leffler's regression were, in fact, based on a one-tailed test, his results are still not statistically significant. For one-tailed tests, it is generally accepted that results are only statistically significant if the t-statistic is greater than 1.65, which in this case it is not. The associated lower value for the 95% confidence interval here is 439 – (1.65) (272.32) = -10.3, so the related 95% confidence interval is (-10.3, ∞). The fact that zero is in this interval is the same fact that the null hypothesis that the regression coefficient is zero is not rejected at the 5% level in a one-tailed test.

generally that .05 is the pre-specified constant that must be met to have a satisfactory level of confidence. This confidence level is routinely applied to the estimates that result from regression analyses of the type Dr. Leffler has performed.

11. Sir Ronald Fisher, a noted statistician, embraced and encouraged acceptance of the 95% level of statistical science and it has been widely accepted ever since. At that level of confidence, statisticians conclude that the null hypothesis can be rejected. Statistical results at lower levels of confidence do not present a sufficiently reliable outcome on which to reject the null hypothesis. Fisher would say that if the null hypothesis is rejected, either it is wrong or something unusual has happened. If it is not rejected, no further conclusions are warranted.

12. Dr. Leffler himself invokes the 95% standard of statistical significance in Paragraph 50 of his Report. (Parenthetically, I understand Dr. Leffler's comment that coefficients are "generally statistically significant" to refer to other coefficients that he includes in Table 12; the $439 coefficient is not statistically significant at the specified level.)

13. The $439 coefficient is not statistically significant at the 95 percent level of confidence. As stated above, for a two-tailed test, a 95 percent level of confidence corresponds to at least 1.96 standard deviations away from zero, and Dr. Leffler's coefficient has a lower number of standard deviations away from zero, at 1.61 (which correspondence to an 89 percent level of confidence). Therefore, the coefficient is not reliable to demonstrate the hypothesis that Dr. Leffler seeks to test, *viz*., whether there was any relationship between price discussions and the actual prices paid for TFT LCD panels.

14. Another way to demonstrate the lack of reliability is by using the range of 95 percent confidence, as discussed above. As noted, Dr. Leffler's regression results demonstrate that, at the 95 percent level of certainty, the actual overcharge is within the range from ***minus*** $95 to $972. Because that range includes zero, the result of the regression does not allow one to reject the null hypothesis, *viz*., the possibility that there was no overcharge. When the "zero" amount falls within the range of the 95 percent confidence level, statisticians and other social scientists generally conclude that the null hypothesis is not rejected and no reliable conclusions can be drawn from the data at hand.

15. Consequently, using standard methodology, the coefficient used by Professor Leffler in his damages calculation is not significantly different from zero at the 5% level of confidence, using either a one- or two-tailed test. It is therefore not reliable to be used for further calculations, such as the determination of overcharge resulting from the conspiracy.

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct. Executed this 7th day of February, 2012 at Pittsburgh, Pennsylvania.

Joseph B. Kadane

Joseph B. Kadane