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ATTACHMENT E

Federal Aviation Administration

Memorandum

Date: OCT 5 2005

From: Bob Robeson, Manager, APO-200 Bob Robeson

To: Barry Molar, Manager, APP-500

Subject: Chicago O'Hare Modernization Program (Phase-1) Benefit Cost Analysis Review

Thank you for the opportunity to review the *Request for Letter of Intent to Provide a Multi-Year Commitment of Airport Improvement Program Grant-in-Aid Funding* OMP Phase-1 dated February 2005 and the supplemental analysis dated September 27, 2005.

APO has reviewed the original benefit-cost analysis (BCA) dated February 2005 and the supplemental analysis dated September 27, 2005. With respect to the original BCA, APO found the analysis deficient in five general areas: (1) methodology used to calculate travel timesavings; (2) incorporation of relevant costs; (3) estimation of downstream benefits; (4) quantification of relevant benefits; and (5) sensitivity analysis.

The original BCA assumed that aircraft operations would remain capped at current levels, rather than growing to reflect natural demand. This assumption resulted in a significant overstatement of the delay savings benefits associated with the proposed project. This and other factors produced a benefit cost ratio (BCR) that could not be substantiated.

In addition, because the original BCA maintained an operational cap, the full economic benefits of the proposed project were not captured, in particular, the societal benefits associated with more choice, lower fares, and greater access to the airport. One approach to estimate such benefits would be to measure changes in social surplus that would result from the proposed project.

A more detailed discussion of our findings is found in an attachment titled "APO-200 Comments on the Benefit-Cost Analysis dated, February 2005." Based on discussions with APP-510, the Chicago Area Modernization Program Office, the airport sponsor, and the contractor that conducted the analysis, our concerns with the original analysis have been recognized. As a result, the airport sponsor has provided the FAA with a supplemental analysis addressing these concerns.

The supplemental analysis document dated September 27, 2005 represents an alternative approach to calculating the benefits from the proposed project. Under this approach, the BCA would typically need to consider both changes in consumer and producer surplus to measure changes in social surplus from the proposed project.[1] However, in this particular case where the air carriers are supporting the project, measuring changes in social surplus solely on the basis of consumer surplus is conservative and appropriate.

The supplemental analysis relies on changes in consumer surplus as a measure of the benefits of the proposed project. The use of consumer surplus to measure such benefits is widely recognized in the economic transportation literature and is discussed in general terms in Appendix C of the FAA's BCA Guidance. To assist the applicant in correctly applying this approach, FAA's Airport Office requested that GRA, an economic consulting firm specializing in transportation, prepare a document describing its application. The GRA memorandum describes a situation in which changes in consumer surplus measure the benefit to the consumer resulting from a capacity expansion project, despite the fact that delays at the airport return to current conditions during the period of the proposed project.

Our review of the supplemental analysis is limited to *Master Plan Phase 1*. While the benefits measured are identical to those reported for *OMP Airfield Phase 1*, Master Plan Phase 1 includes the relevant set of costs (e.g., costs associated with the Lima-Lima taxiway, the Western Concourse, and the Concourse K extension) necessary for a proper evaluation of the proposed project because the benefits from OMP Phase 1 will not be fully realized unless this non-LOI construction is also accomplished.

Based on a review of the sensitivity analyses reported in the document, it appears that the benefits sufficiently exceed the projected costs over a plausible range of parameters. Although not discussed in the supplemental BCA, a review of the data also suggests that in the unlikely event that one of the two hub carriers serving O'Hare would exit the market, the benefits of the proposed project would continue to exceed the costs over the same range of parameter values. In addition, it should be noted that the benefits as reported in the BCA are probably understated due to the fact that the supplemental analysis did not attempt to quantify either the downstream or system-wide ripple benefits associated with the proposed project.

A more comprehensive discussion of our review of the supplemental analysis is found in the attachment titled "APO-200 Comments on the Supplemental Benefit-Cost Analysis dated September 27, 2005." This discussion is broken out into two topic areas: Sensitivity Analysis and General Comments.

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[1] Consumer surplus is the amount that consumers benefit by being able to purchase a service for a price that is less than they would be willing to pay. Similarly, producer surplus is the amount that producers benefit by selling at a price that is higher than they would be willing to sell for. Social surplus is the sum of consumer and producer surplus.

Attachment I
APO-200 Comments on the Benefit-Cost Analysis dated, February 2005

Methodology Used to Calculate Travel Time Savings

- The analysis inappropriately uses the same level of aircraft operations (974,000) for calculating travel time differentials between the base case and the OMP Phase-1 alternative. By using the same level of operations, the travel time saving benefits associated with OMP Phase-1 were significantly overstated. To remedy this shortcoming of the analysis, the travel times associated with the OMP Phase-1 alternative should be based on the unconstrained forecast. Once average annual delays reach levels comparable to those estimated under the base case, the level of aircraft operations should once again be capped.

- The analysis should address whether the construction phase of the projects will negatively impact the travel time saving benefits estimated above.

- Given that under OMP Phase-1 there will be greater passenger throughput at the airport, it is also necessary to account for any resulting landside delays that would tend to offset the benefits calculated above.

- The BCA appears to take credit for full hourly block-to-block aircraft variable operating costs (VOC), as opposed to controlling for the fact that some delays occur just on the ground and do not entail full fuel burn. Based on APO research, we have found that the fuel component represents approximately 33 percent of ORD's aircraft VOC. Applying that factor to delays with little or no fuel burn (e.g., the 18 percent of ORD's delays that are departures) would suggest that the BCA's VOC benefits (cost savings) are overstated by 6 percent.

- The BCA uses the Gross Domestic Price deflator to adjust aircraft VOC from 2004 to 2001dollar denominations. This approach is inconsistent with FAA guidance in FAA's "Economic Values for Evaluation of Federal Investment and Regulatory Programs" which states that the fuel component of the VOC should be adjusted with a fuel price index. Failure to follow this guidance has resulted in an overstatement of the non-discounted aircraft variable operating cost savings by about 5 percent.

Incorporation of Relevant Costs

- It appears that the BCA does not include all of the relevant costs associated with the benefits derived under OMP Phase-1. Because the delay calculations associated with the OMP Phase-1 alternative appear to dependent, in part, on two projects – the Lima-Lima Taxiway and a portion of the Western Terminal Complex -- for which their costs have been excluded from the analysis, the analysis must be adjusted to reflect this dependency. To correct this shortcoming, these costs should be included in the analysis, regardless of whether the projects are eligible for AIP funding or the delay savings associated with OMP Phase-1 should be recalculated without the inclusion of those projects. An alternative, but less

desirable approach would be to creditably analyze and document why one or both projects have no material impact on OMP Phase-1 delay savings.

- While much less significant than the costs associated with the Lima-Lima Taxiway and a part of the Western Terminal Complex, the analysis appears to omit environmental/dismantling costs associated with the salvage value associated with OMP Phase-1. In addition, salvage value was treated as a benefit rather than an offset to costs. While this does not affect the net present value of the proposed project, it does have a minor impact on the benefit/cost ratio.

- The analysis also appears to inappropriately treat some land acquisition costs as sunk costs. As a result, these costs do not appear to have been included in the analysis (see page IV-18). The definition of a sunk cost is a resource cost that has already been consumed and cannot be recovered. By re-selling the land, these costs can always be recovered and consequently should not be considered sunk.

Estimation of Downstream Benefits

The analysis applies a factor of 0.8 to estimate the benefits of averted downstream delays that would accrue from the capacity improvements at ORD. This factor was taken from an MIT report cited in the FAA's Airport Benefit-Cost Analysis Guidance. That generalized and preliminary report concluded that the net system-wide delay for an aircraft due to an initial flight delay at a given airport is approximately 1.8 times that initial delay. Because of the size and nature of airline operations at O'Hare, we agree that there would be downstream benefits associated with OMP Phase-1. However, the BCA failed to develop an appropriate methodology for measuring these downstream benefits and inappropriately relied on the illustrative downstream multiplier cited in the MIT report. The BCA must either include an acceptable methodological approach to measuring downstream benefits or demonstrate why the 0.8 multiplier chosen is appropriate.

Quantification of Relevant Benefits

While the focus of the BCA was to quantify benefits associated with travel timesavings, our review of OMP Phase-1 suggests that the other benefit categories may in fact be the more relevant benefits to quantify. The BCA noted a number of potential benefit categories in Table IV-1, but only quantified the benefits associated with "Reduced aircraft, passenger during normal airport operations" and " Improved efficiency of traffic flows (reduced vectoring and taxiing distances)." Once the BCA is adjusted to properly estimate travel time saving benefits, as noted above, the benefits associated with this category are reduced. As such we suggest that the airport sponsor rethink its methodology for identifying benefits and attempt to quantify those benefits not previously quantified. One approach would be to consider the approach described in Appendix C of FAA's Airport Benefit-Cost Analysis Guidance.

Sensitivity Analysis

As is noted in FAA's Airport Benefit-Cost Analysis Guidance, sensitivity analysis is an important tool for evaluating the impacts of uncertainty on proposed investment projects. The basic approach is to vary key assumptions, estimates, and forecasts systematically over appropriate ranges and observe the impact on the results. For certain items, the impact may be insignificant while for others it may be quite large. In some cases the relative desirability of competing alternatives may be altered while in others it will not be. While the BCA did conduct a number of sensitivity tests, if did not consider two potentially important areas which are explicitly noted in FAA's BCA guidance.

- The first is with respect to forecasted traffic levels. In the BCA it is noted that the 2002 Terminal Area Forecast (TAF) was chosen to ensure consistency with the DEIS. However, as noted in section 1.5.1 of the DEIS, in approving the use of the 2002 TAF for the DEIS, FAA noted that the DEIS would need to review any new forecasts and conduct sensitivity analysis as appropriate. Similarly, such sensitivity analysis should also have been conducted as a part of the BCA. As the FAA's BCA guidance notes:

  > [w]here actual traffic varies from forecast traffic, the analyst should endeavor to understand why this is so and make appropriate adjustments to the forecast by modifying the data base used to generate the forecast and/or the forecasting method. Use of a forecast made in a prior year that conflicts with recent traffic data and/or forecasts will obviously undermine the credibility of a BCA based on it. (p. 13)

  To ensure that the analysis is sufficiently robust with respect to various operational levels, some sensitivity analysis should be conducted with respect to the FY 2004 forecast which is the most recent forecast.

- The second is with respect to the possible failure of one of O'Hare's two primary hub airlines, e.g., United Airlines. Within the DEIS, the need to conduct sensitivity analysis with respect to the possible failure of a hubbing airline was addressed. FAA's BCA guidance also notes the need for such sensitivity analysis. In particular, the guidance notes that the analysis should:

  > [c]onsider the effects of changes in uncertain factors affecting demand for the airport services--Major components of airport demand may be driven by the continued existence of a particular hub service or fixed base operator (FBO). Clearly, if there is a reasonable possibility that the hub operation will be discontinued or the FBO will close down, the impact of this event on the forecast should be quantified. Contingencies such as this must be specifically addressed in BCA sensitivity analysis. (p. 13)

  To determine how robust the model results are to the potential failure of a hub carrier, some sensitivity analysis should be conducted.

Attachment II
APO-200 Comments on the Supplemental
Benefit-Cost Analysis dated September 27, 2005

Sensitivity Analysis

- As noted in the discussion of the original BCA, the use of sensitivity analysis is an important tool for evaluating the impacts of uncertainty of proposed investment projects. When measuring project benefits based on an economic model, its use plays an even more important role. As is normally the case, an economic model is developed based on a number of critical assumptions, testing how sensitive the BCR is to changes to these assumptions is essential for evaluating whether the benefits of the proposed project exceed the projected costs. The airport sponsor has submitted a number of mutli-attribute sensitivity analyses that indicate that the proposed project is cost beneficial over a plausible range of parameters.

  In the first multi-attribute sensitivity analysis titled Table A-12, the BCR is above one for the entire range of parameter values. Here the elasticity of demand was varied from –0.5 to –2.5 while the money fare was varied from $55.01 to $385.09.

Table A-12

Elasticity and Money Fare Sensitivity Analysis Summary, Master Plan Phase I

		Money Fare								
		$55.01	$110.03	$165.04	$198.05	$220.05	$242.06	$275.06	$330.08	$385.09
		-75%	-50%	-25%	-10%	0%	10%	25%	50%	75%
Elasticity	-0.50	4.81	6.70	8.59	9.72	10.48	11.23	12.36	14.25	16.14
	-0.60	4.06	5.65	7.25	8.20	8.84	9.48	10.43	12.03	13.62
	-0.70	3.51	4.89	6.27	7.10	7.65	8.20	9.02	10.40	11.78
	-0.80	3.10	4.31	5.52	6.25	6.74	7.22	7.95	9.16	10.38
	-0.90	2.77	3.85	4.94	5.59	6.02	6.45	7.11	8.19	9.28
	-1.00	2.50	3.48	4.46	5.05	5.44	5.83	6.42	7.40	8.38
	-1.10	2.28	3.18	4.07	4.61	4.97	5.32	5.86	6.75	7.65
	-1.18	2.13	2.97	3.80	4.30	4.64	4.97	5.47	6.31	7.14
	-1.30	1.94	2.70	3.46	3.92	4.22	4.53	4.99	5.75	6.51
	-1.40	1.81	2.51	3.22	3.65	3.93	4.21	4.64	5.35	6.06
	-1.50	1.69	2.35	3.01	3.41	3.68	3.94	4.34	5.00	5.66
	-1.60	1.59	2.21	2.83	3.20	3.45	3.70	4.07	4.70	5.32
	-1.70	1.50	2.08	2.67	3.02	3.25	3.49	3.84	4.43	5.01
	-1.80	1.41	1.97	2.52	2.86	3.08	3.30	3.63	4.19	4.74
	-1.90	1.34	1.87	2.39	2.71	2.92	3.13	3.44	3.97	4.50
	-2.00	1.28	1.78	2.28	2.58	2.78	2.98	3.28	3.78	4.28
	-2.10	1.22	1.69	2.17	2.46	2.65	2.84	3.12	3.60	4.08
	-2.20	1.16	1.62	2.07	2.35	2.53	2.71	2.98	3.44	3.89
	-2.30	1.11	1.55	1.98	2.25	2.42	2.59	2.86	3.29	3.73
	-2.40	1.07	1.48	1.90	2.15	2.32	2.49	2.74	3.16	3.57
	-2.50	1.02	1.43	1.83	2.07	2.23	2.39	2.63	3.03	3.43

Source: Ricondo & Associates, Inc.
Note: Shaded cell is the original BCR.

An alternative sensitivity analysis was conducted allowing the values for the price elasticity of demand to vary, as above, while at the same time reducing the level of passenger demand from the Scenario Forecast. Over a plausible range of price elasticities of demand (e.g., -0.8 to –2.0), the proposed project appears to be cost beneficial so long as the percentage reduction in passenger growth does not fall by more than approximately 5 percent from the Scenario Forecast. This particular sensitivity test maintained the number of aircraft operations consistent with the Scenario Forecast, but varied the number of passengers. (See the multi-attribute analysis titled Table A-14)

Table A-14

Elasticity and Future Demand Sensitivity Analysis Summary, Master Plan Phase I

		Variations in Scenario Case Passengers										
		-10%	-9%	-8%	-7%	-6%	-5%	-4%	-3%	-2%	-1%	0%
Elasticity	-0.50	0.01	0.21	0.81	1.69	2.67	3.75	4.92	6.20	7.56	9.03	10.48
	-0.60	0.01	0.17	0.68	1.41	2.23	3.14	4.13	5.21	6.37	7.61	8.84
	-0.70	0.01	0.15	0.58	1.22	1.92	2.71	3.56	4.49	5.50	6.58	7.65
	-0.80	0.01	0.13	0.51	1.07	1.69	2.38	3.13	3.95	4.84	5.79	6.74
	-0.90	0.01	0.12	0.45	0.95	1.50	2.12	2.79	3.53	4.32	5.17	6.02
	-1.00	0.01	0.10	0.41	0.85	1.35	1.91	2.52	3.18	3.90	4.67	5.44
	-1.10	0.00	0.10	0.37	0.78	1.23	1.74	2.30	2.90	3.56	4.26	4.97
	-1.18	0.00	0.09	0.35	0.73	1.15	1.62	2.14	2.71	3.32	3.98	4.64
	-1.30	0.00	0.08	0.31	0.66	1.05	1.48	1.95	2.46	3.02	3.63	4.22
	-1.40	0.00	0.07	0.29	0.61	0.97	1.37	1.81	2.29	2.81	3.37	3.93
	-1.50	0.00	0.07	0.27	0.57	0.91	1.28	1.69	2.14	2.63	3.15	3.68
	-1.60	0.00	0.07	0.26	0.54	0.85	1.20	1.59	2.01	2.47	2.96	3.45
	-1.70	0.00	0.06	0.24	0.51	0.80	1.13	1.50	1.89	2.33	2.79	3.25
	-1.80	0.00	0.06	0.23	0.48	0.76	1.07	1.42	1.79	2.20	2.64	3.08
	-1.90	0.00	0.06	0.22	0.45	0.72	1.02	1.34	1.70	2.08	2.50	2.92
	-2.00	0.00	0.05	0.20	0.43	0.68	0.97	1.28	1.61	1.98	2.38	2.78
	-2.10	0.00	0.05	0.19	0.41	0.65	0.92	1.22	1.54	1.89	2.27	2.65
	-2.20	0.00	0.05	0.19	0.39	0.62	0.88	1.16	1.47	1.80	2.17	2.53
	-2.30	0.00	0.05	0.18	0.37	0.59	0.84	1.11	1.41	1.73	2.07	2.42
	-2.40	0.00	0.04	0.17	0.36	0.57	0.81	1.07	1.35	1.66	1.99	2.32
	-2.50	0.00	0.04	0.16	0.34	0.55	0.77	1.02	1.30	1.59	1.91	2.23

Source: Ricondo & Associates, Inc.
Note: Shaded cell is the original BCR.

The final multi-attribute sensitivity analysis (See Table A-16) was conducted by allowing the money fare to vary along with the level of passenger demand. Taking a 5 percent reduction in passenger demand as a reasonable upper limit, the vast majority of BCRs are significantly above one.

Table A-16

Money Fare and Future Demand Sensitivity Analysis Summary, Master Plan Phase I

Variations in Scenario Case Passenger		Money Fare								
		$55.01	$110.03	$165.04	$198.05	$220.05	$242.06	$275.06	$330.08	$385.09
		-75%	-50%	-25%	-10%	0%	10%	25%	50%	75%
	-10%	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
	-9%	0.04	0.06	0.07	0.08	0.09	0.10	0.10	0.12	0.14
	-8%	0.16	0.22	0.28	0.32	0.35	0.37	0.41	0.47	0.53
	-7%	0.33	0.46	0.60	0.67	0.73	0.78	0.86	0.99	1.12
	-6%	0.53	0.74	0.94	1.07	1.15	1.23	1.36	1.56	1.77
	-5%	0.75	1.04	1.33	1.51	1.62	1.74	1.91	2.21	2.50
	-4%	0.99	1.37	1.76	1.99	2.14	2.30	2.53	2.91	3.30
	-3%	1.25	1.73	2.22	2.51	2.71	2.90	3.19	3.68	4.17
	-2%	1.53	2.13	2.72	3.08	3.32	3.56	3.92	4.51	5.11
	-1%	1.83	2.55	3.26	3.69	3.98	4.27	4.70	5.41	6.13
	0%	2.13	2.97	3.80	4.30	4.64	4.97	5.47	6.31	7.14

Source: Ricondo & Associates, Inc.
Note: Shaded cell is the original BCR

Taken together these three sensitivity tests plus the sensitivity test of using a 2004 TAF suggest that the model results are robust with respect to changes in a number of key parameters.

- Although not discussed in the supplemental BCA, a review of the data also suggests that in the unlikely event that one of the two hub carriers serving O'Hare would exit the market, the benefits of the proposed project would continue to exceed the costs over the same range of parameter values noted above. The reason for this result is that the loss of a hub carrier would occur in both the base and scenario cases. While the loss of a hub carrier would result in changes to the Chicago market in the form of changes in delays, aircraft operations, passenger levels, and money fares, there would be very little impact on the net benefits since it is the difference between the two cases that is relevant for the BCA and this change is minimal under a rather conservative set of assumptions.

General Comments

- As noted above, the BCA results are probably understated given that the analysis did not attempt to quantify either the downstream or system-wide ripple effect benefits associated with the proposed project. Combined these benefits could be significant.

- The BCA continues not to discuss any potential landside delays resulting from the proposed project.

- Page 17, Table V-1 incorrectly refers to a sunk cost value of $105.1 million. This correct value is $50.1 million.

  Page 78, Table E-1, Benefit-Cost Analysis Summary – It appears that the costs reported include both Phase1 and Phase 2 costs, the consumer surplus benefits are based primarily on the benefit stream reported for Master Plan Phase 1. To properly assess whether the Total Master Plan is cost beneficial, each of the separate stand-alone phases of the project should be evaluated on their own to ensure that the benefits from one phase are not offsetting the costs in another phase.