International Civil Aviation Organization

WORKING PAPER

INTERNATIONAL CIVIL AVIATION ORGANIZATION

SOUTH AMERICAN OFFICE

ICAO SPECIAL IMPLEMENTATION PROJECT (SIP)

WORKSHOP ON THE DEVELOPMENT OF BUSINESS CASE FOR THE IMPLEMENTATION OF CNS/ATM SYSTEMS

(LIMA , 10 − 14 NOVEMBER 2008)

Agenda Item 5: Hands-on exercises for the development of business case

CNS/ATM SYSTEMS IMPLEMENTATION BUSINESS CASE SOFTWARE (DFACS)

ILLUSTRATIVE APPLICATION

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CNS/ATM SYSTEMS IMPLEMENTATION
BUSINESS CASE SOFTWARE
(DFACS)

ILLUSTRATIVE APPLICATION

Version 1.0
October 2006

This illustrative example is based on a State in the Middle East Region and is presented only for illustrative purposes. The required data and parameters are provided in the appendix of this document.

LAUNCHING THE PROGRAM

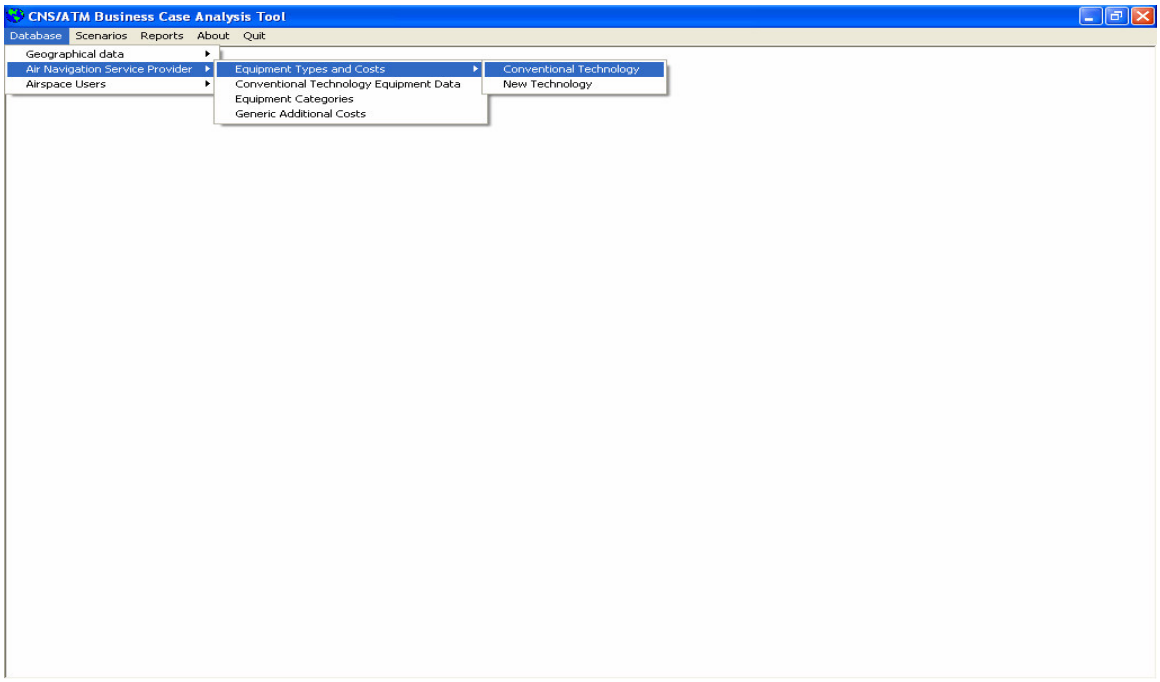
Open the CNS/ATM Business Case Analysis Tool either by double-clicking on the corresponding icon on the desktop or by selecting it from Programs list, as shown in the figure below:

Before the user starts creating scenarios for the implementation of the new air navigation systems, the required reference data has to be entered. This data includes the list of conventional technology and new technology equipments types, the list of aircraft types, the list of avionics along with their respective costs in addition to the list of air navigation conventional technology equipment currently installed in the homogeneous ATM area concerned. Once this data is entered, the user can start building scenarios. There is no limit to the number of scenarios that can be built using this analysis tool.

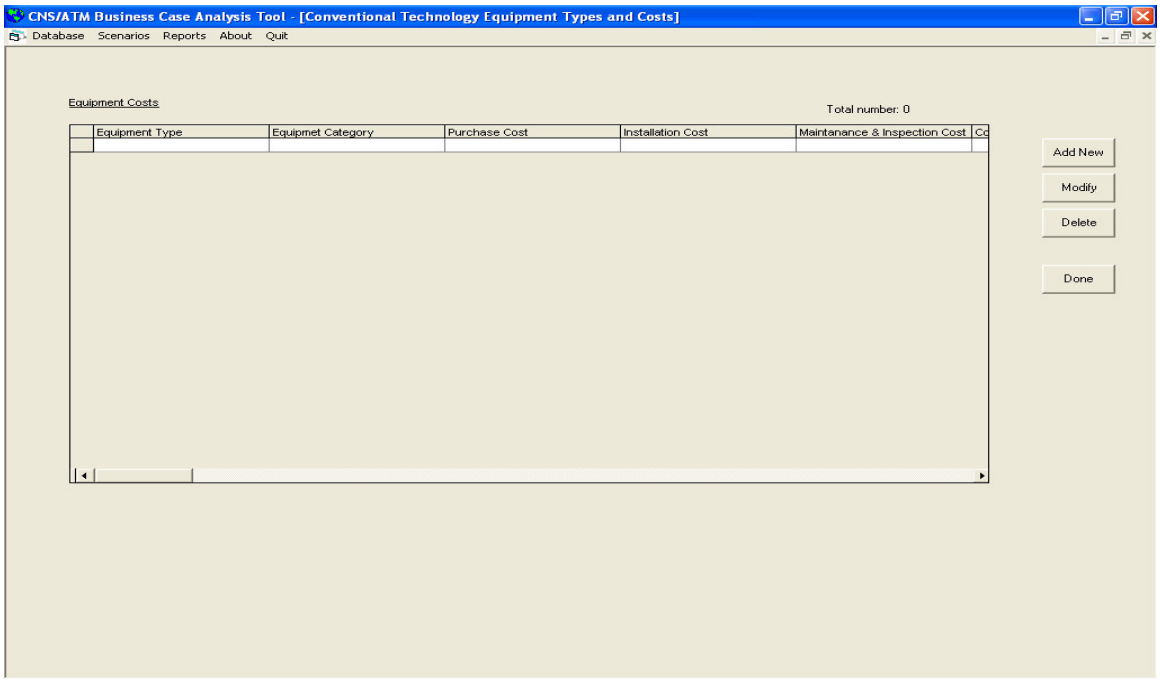
The following section describes the procedure to follow in order to create or update the database.

CREATING OR UPDATING THE DATABASE FOR THE AIR NAVIGATION SERVICE PROVIDER (ANSP)

The first step is to enter the required data, given in the appendix, using the **Database** menu item. In order to enter the cost and life cycle data for the Conventional Technology Equipment, click on the **Database** menu item. Select **Air Navigation Service Provider,** and then **Conventional Technology** as shown in the following screen**.**

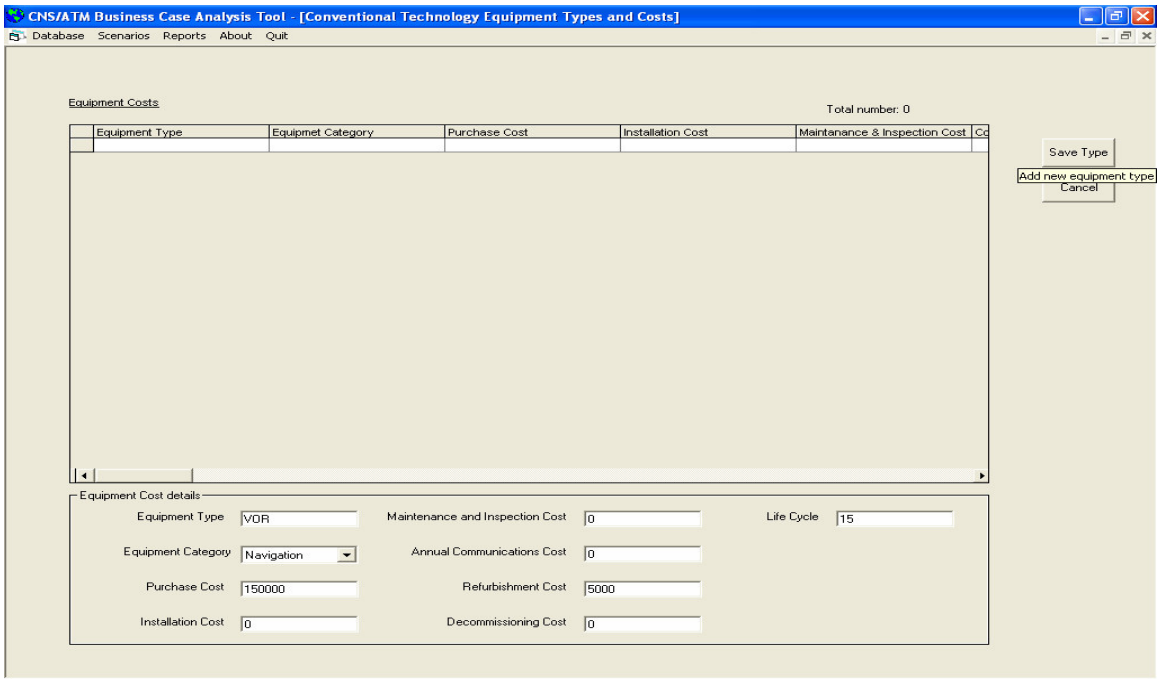


Upon clicking **Conventional Technology,** the screen for entering equipment costs of conventional technology appears as shown in the screen below.

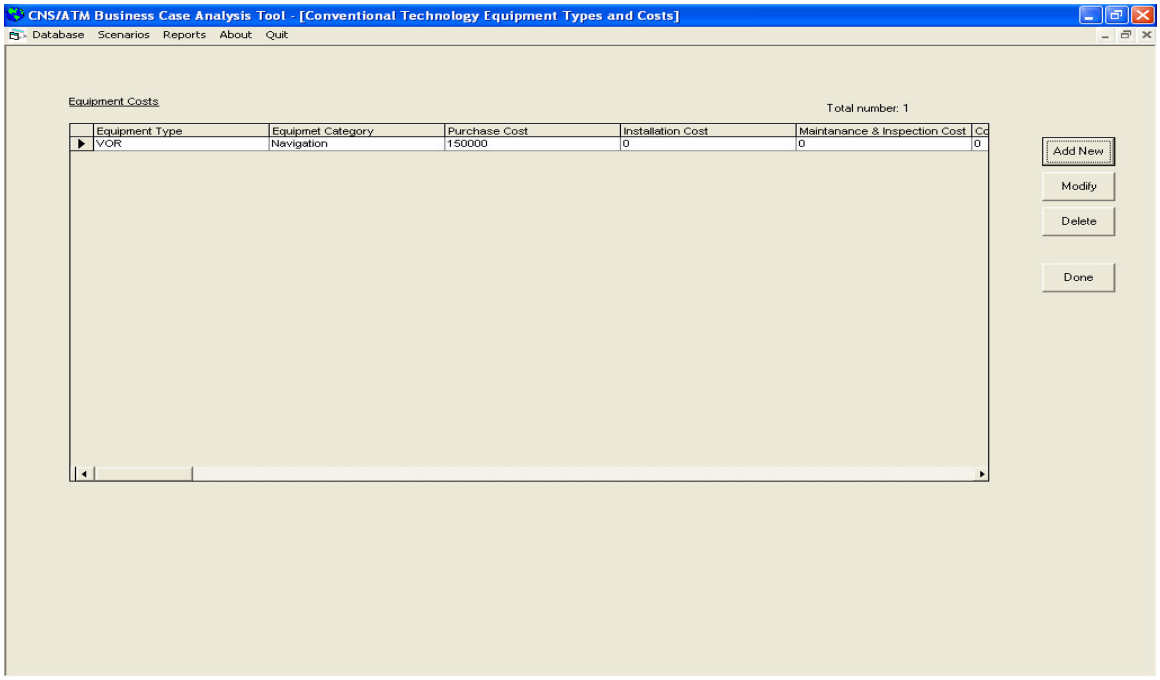


Click on the "**Add New"** command button on the top right of the screen. The equipment type, purchase cost, installation cost, maintenance cost, communication cost, refurbishment cost and decommissioning cost as given in Table 1 can be entered. The lower part of the screen is for entering the detailed data for each equipment type. Click on the cell corresponding to equipment type in the lower window and type VOR. Move on to the next cell corresponding to Equipment Category and select "Navigation" from the drop down list.

Move on to Purchase cost cell and enter the appropriate cost figure, then fill in the other costs as well as the equipment life cycle.

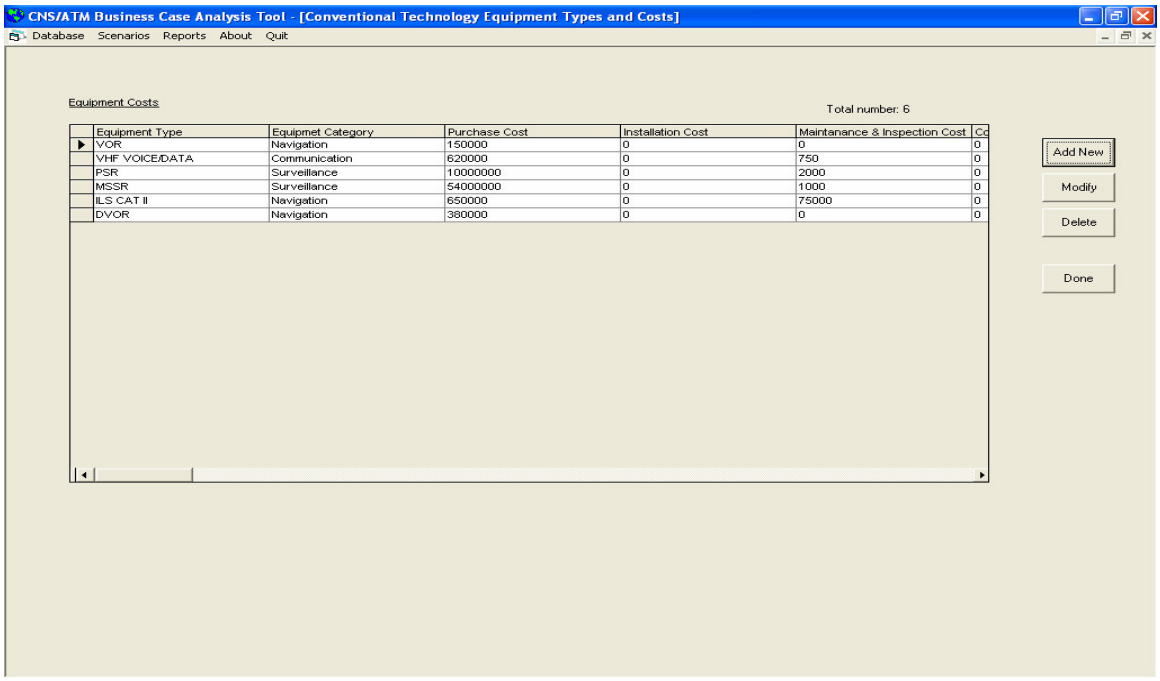


Save equipment type data by clicking on the command button "**Save Type".** The data will now be displayed in the upper window of the screen. Data for this equipment type can be modified or deleted using the respective command buttons on the top right side.

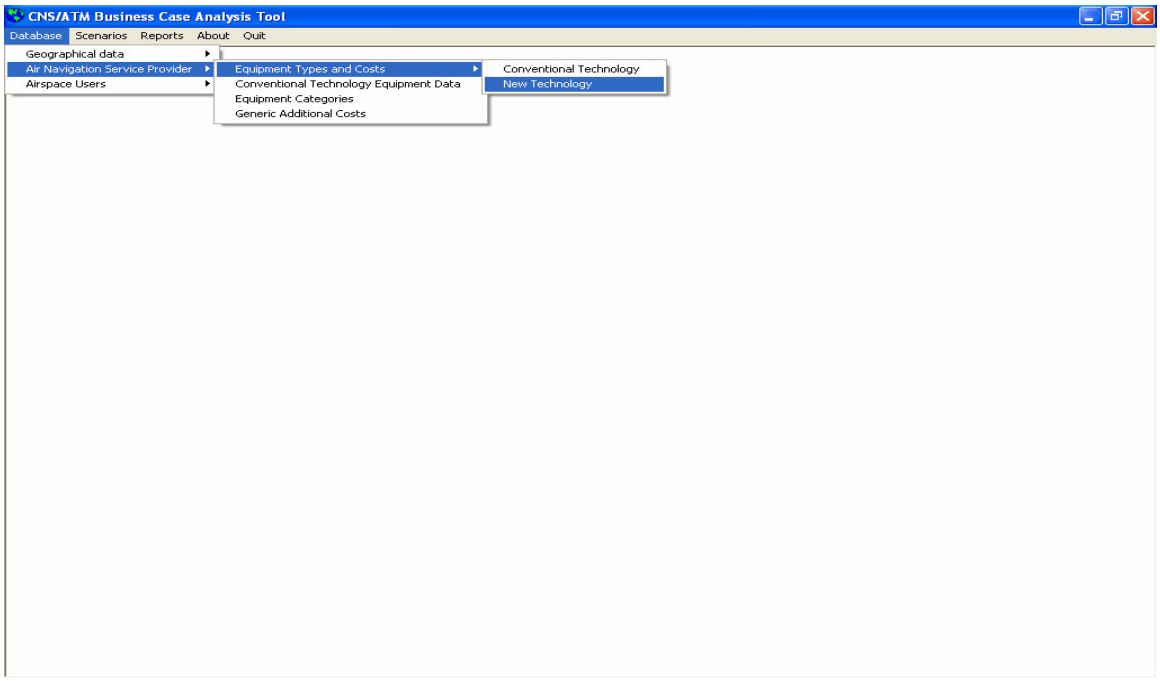


To enter the data on additional equipment types, the "**Add New"** button is invoked again, and the process is repeated until the data for all equipment types is entered. After entering data for all conventional technology equipment types, the screen can be closed by clicking on

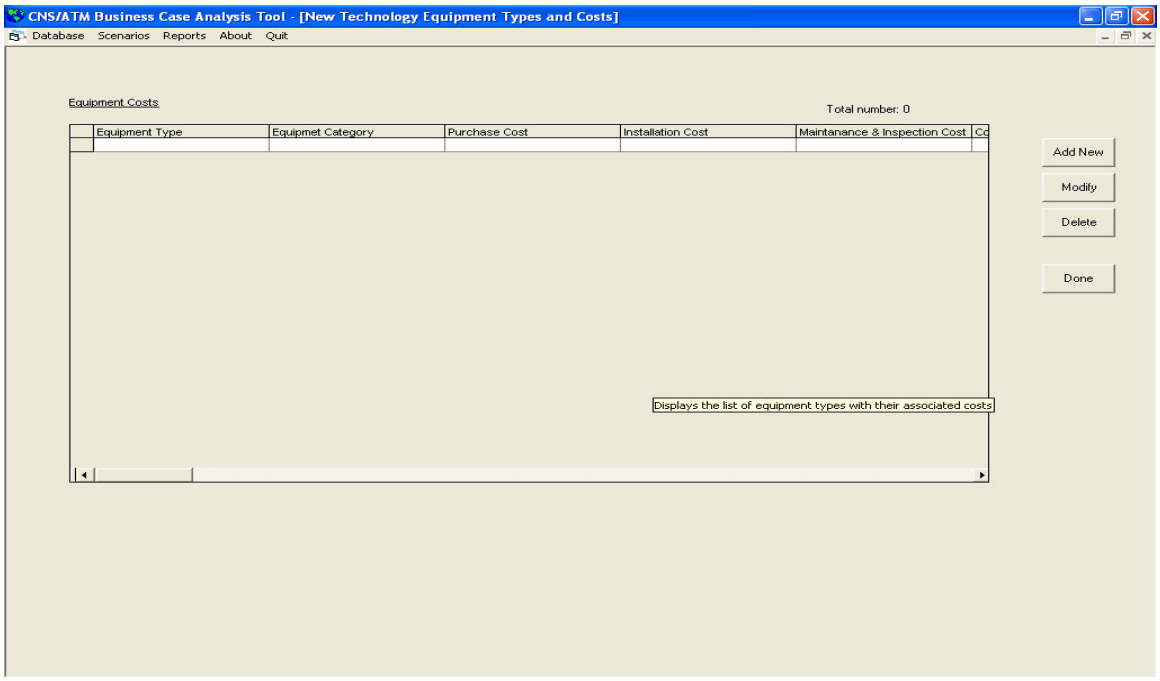
the command button "**Done"**. In this illustrative case, the following screen shows the data entered for the conventional technology equipment.



To enter the cost and life cycle data for New Technology Equipment, Click on the **database** menu item. Select **Air Navigation Service Provider,** and then **New Technology** as shown in the following screen**.**

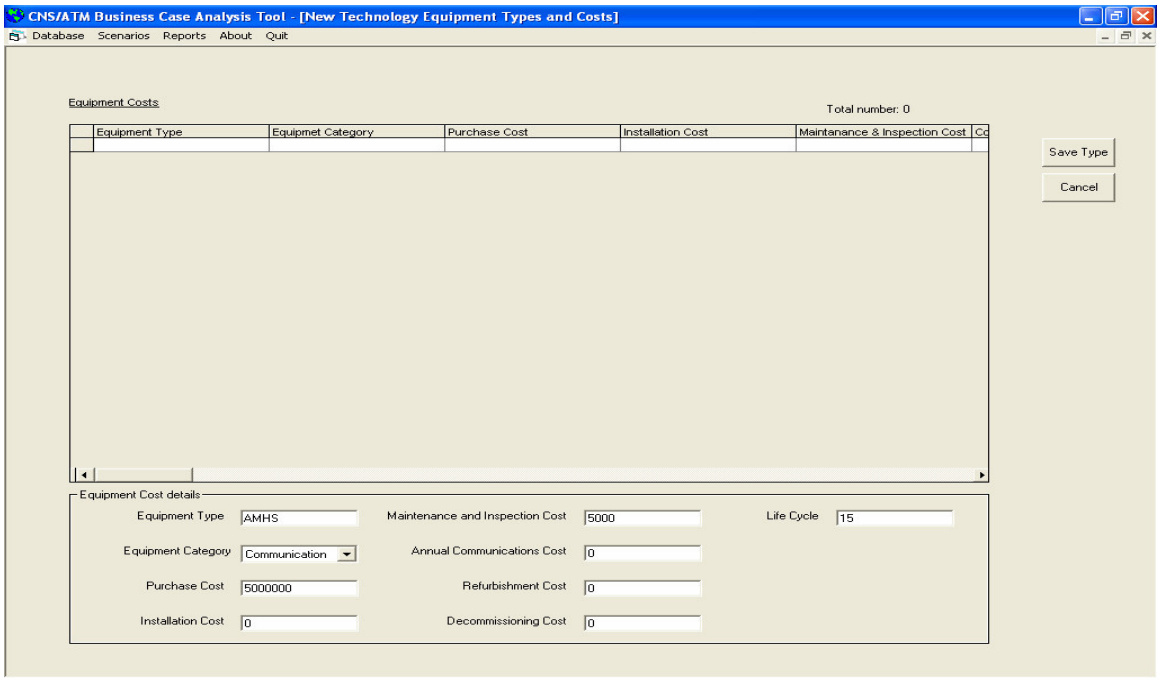


Click on **New Technology** and the following screen for entering equipment costs of new technology appears.

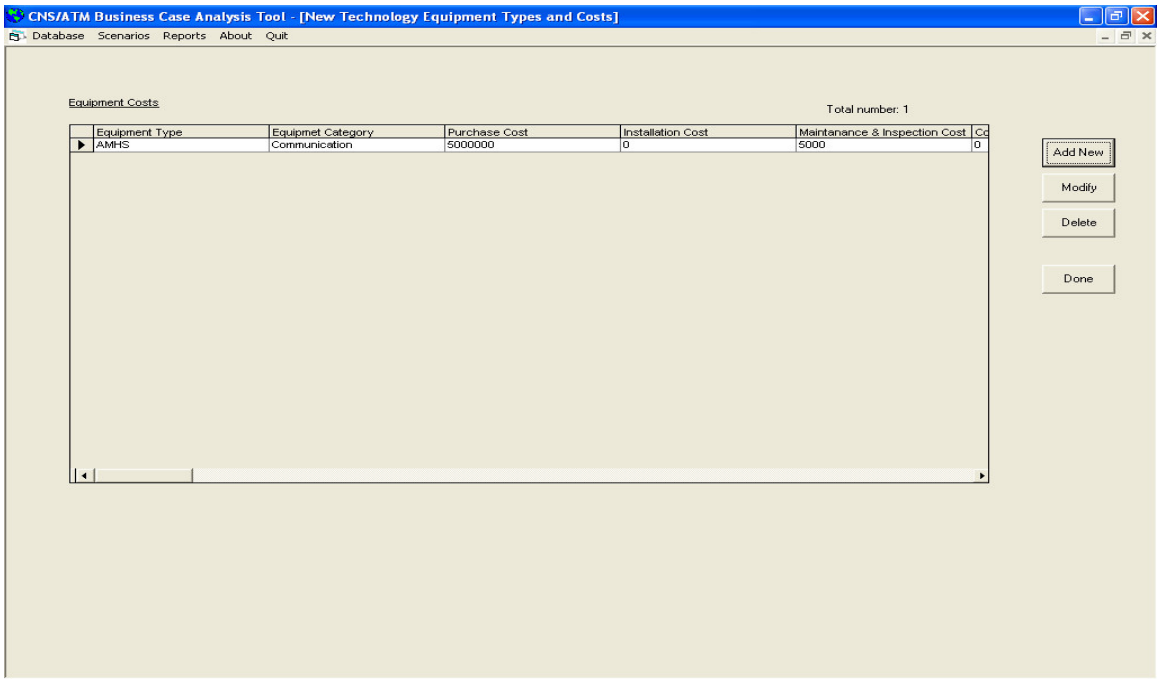


The list of new technology equipment given in Table 2 of the appendix, including the equipment type, purchase cost, installation cost, maintenance cost, communication cost, refurbishment cost, decommissioning cost and life cycle is entered as described in the following paragraph.

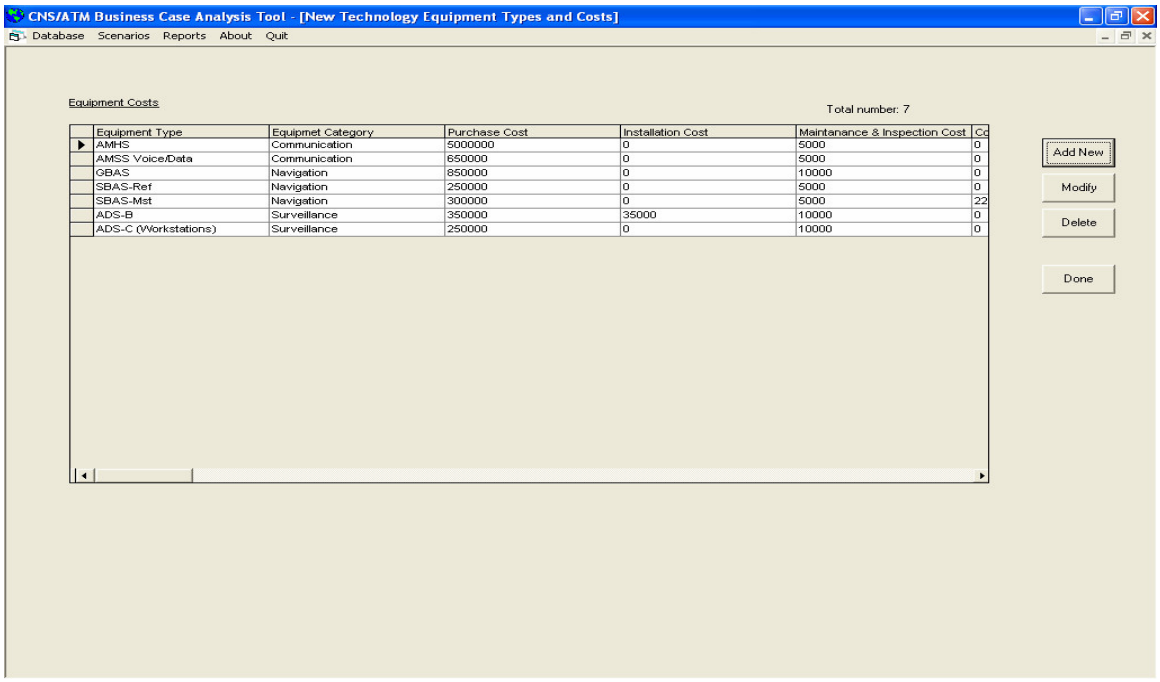
Click on the "**Add New"** command button on the top right of the screen. The lower part of the screen is for entering the detailed data for each equipment type. Click on the cell corresponding to equipment type in the lower window and type AMHS. Move on to the next cell corresponding to Equipment and select "Communication" from the drop down list. Move on to the "Purchase cost" cell and enter the appropriate figure and repeat the process for the other costs and the equipment life cycle.



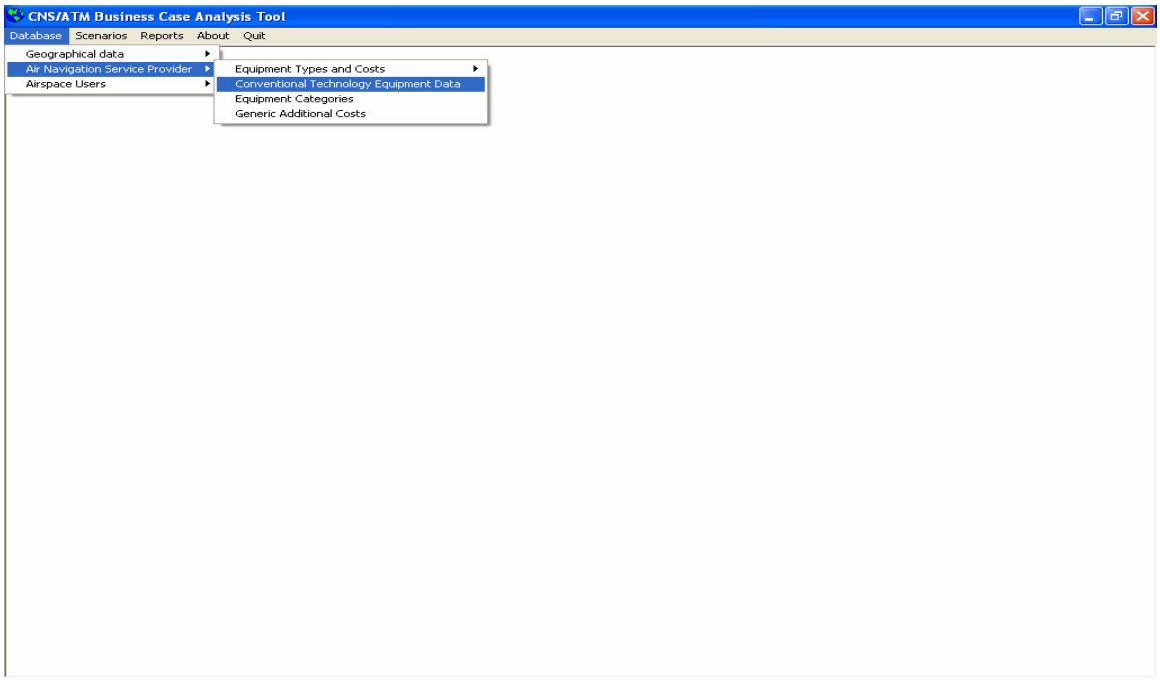
Save equipment type data by clicking on the command button "**Save Type".** The data will now be displayed in the upper window of the screen. Data for this equipment can be modified or deleted by using the respective command buttons on the top right side.



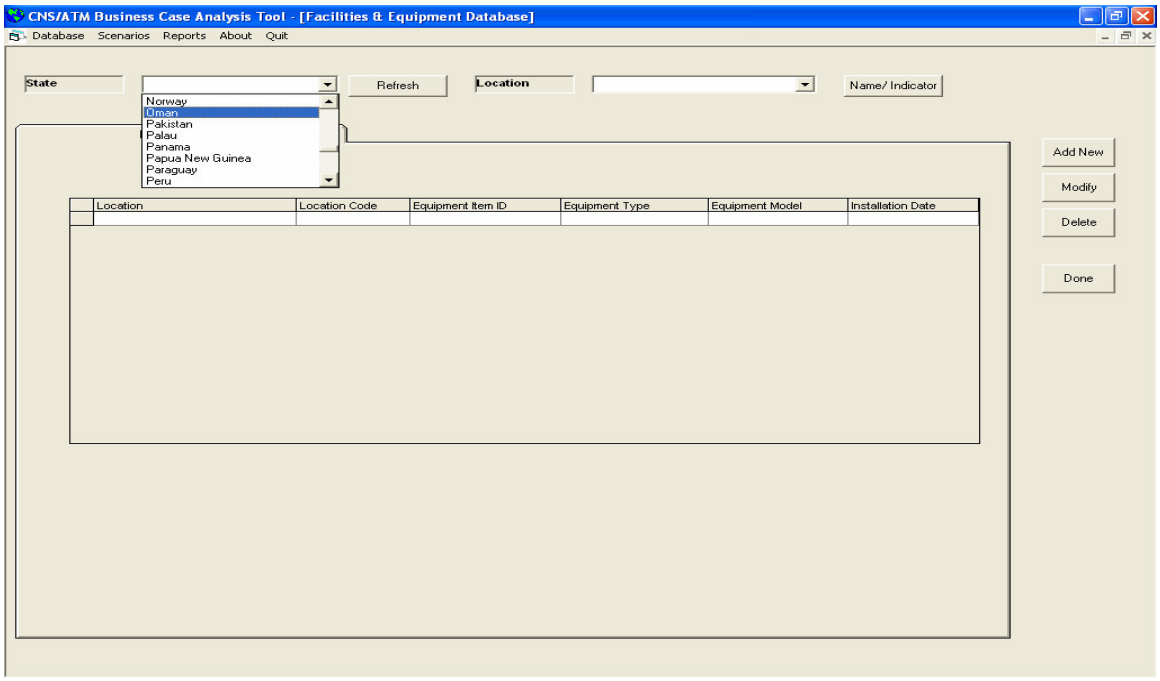
To enter the data for additional equipment types, the "**Add New"** command button is invoked again, and the process is repeated until the data for all equipment types is entered. After entering the data for all new technology equipment types, the screen can be closed by clicking on the command button "**Done"**. In this illustrative case, the following is the data entered for new technology equipment from Table 2.



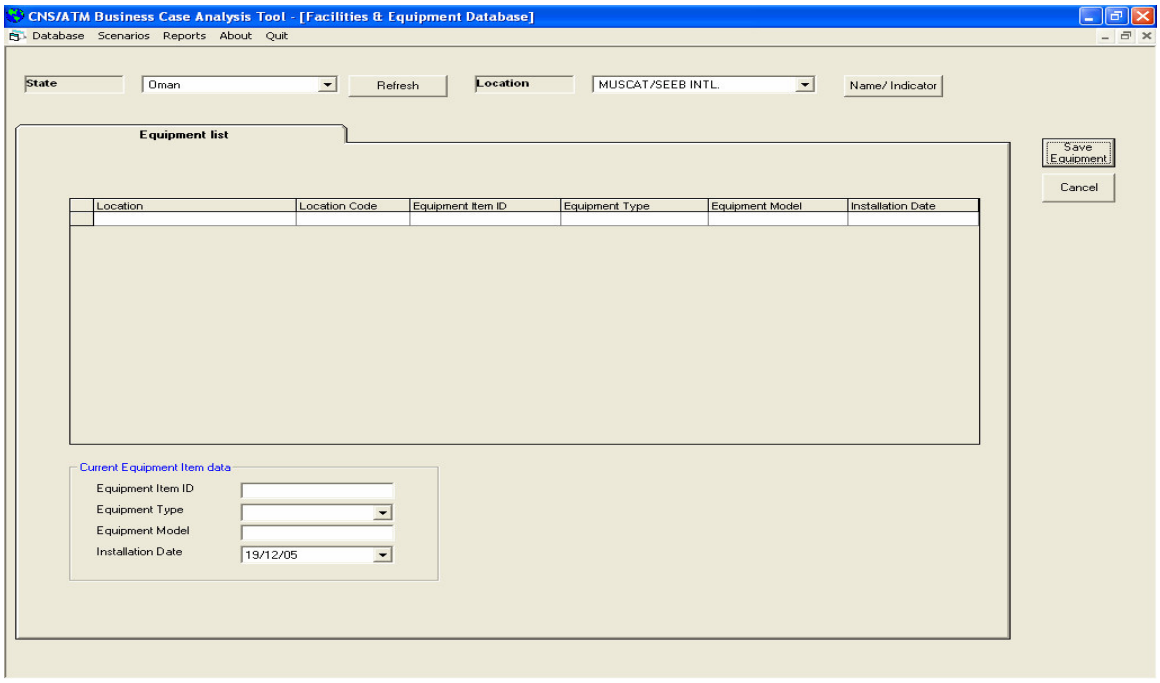
With the given data, the second step is to create or update specific equipment items data by location in the homogeneous area concerned, using the **database** menu item. To do so, click on the **database** menu item. Select **Air Navigation Service Provider** and then **Conventional Technology Equipment Data** as shown in the following screen**.**



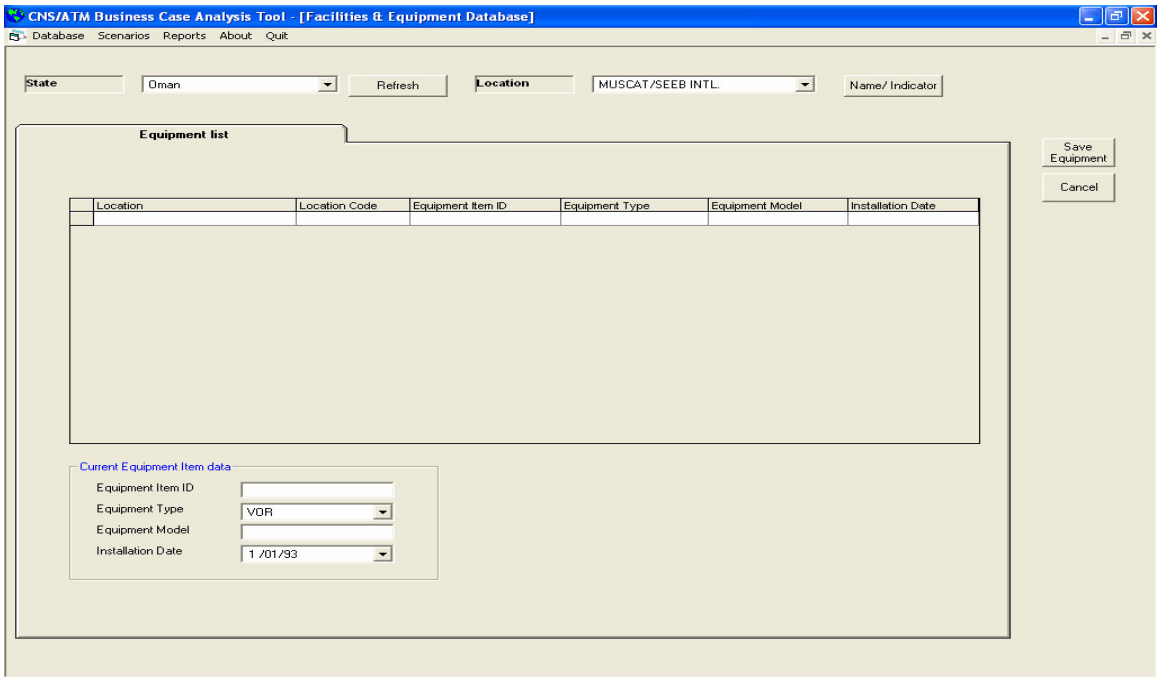
Click on **Conventional Technology Equipment Data.** The following screen will appear. Then select **Oman** from the **State** pull down list**.**



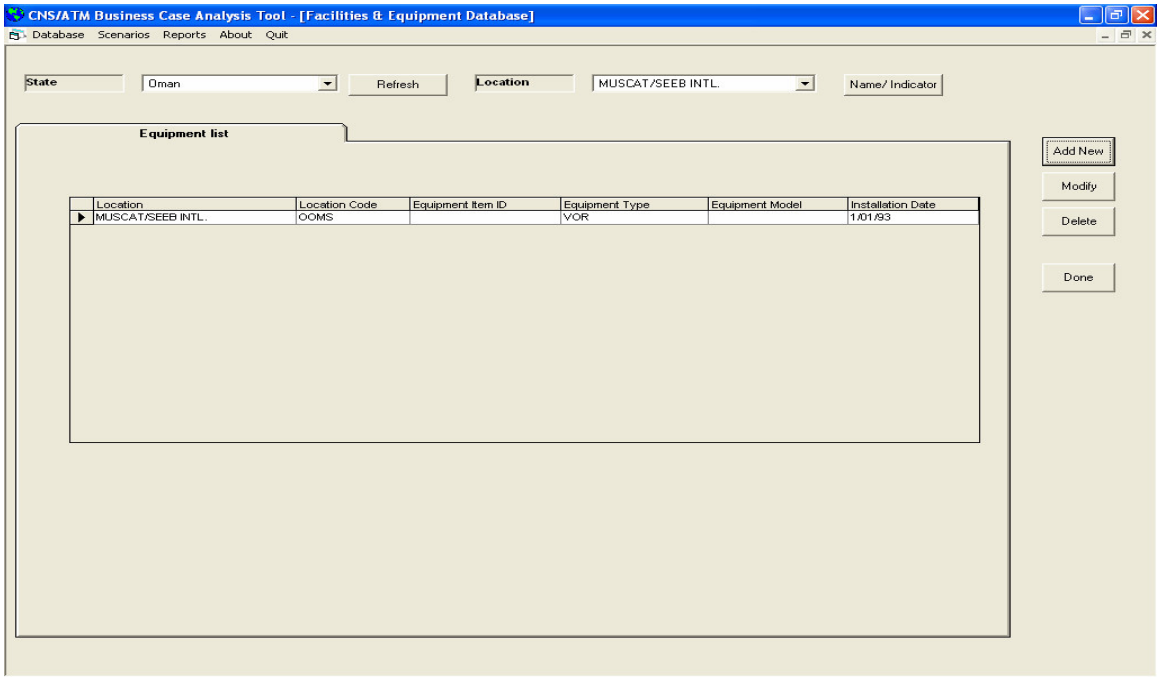
Similarly, select MUSCAT/SEEB INTL location from the **Location** drop-down list on the top right side of the screen and click on the "**Add New"** command button. A sub-window will appear at the bottom of the screen.



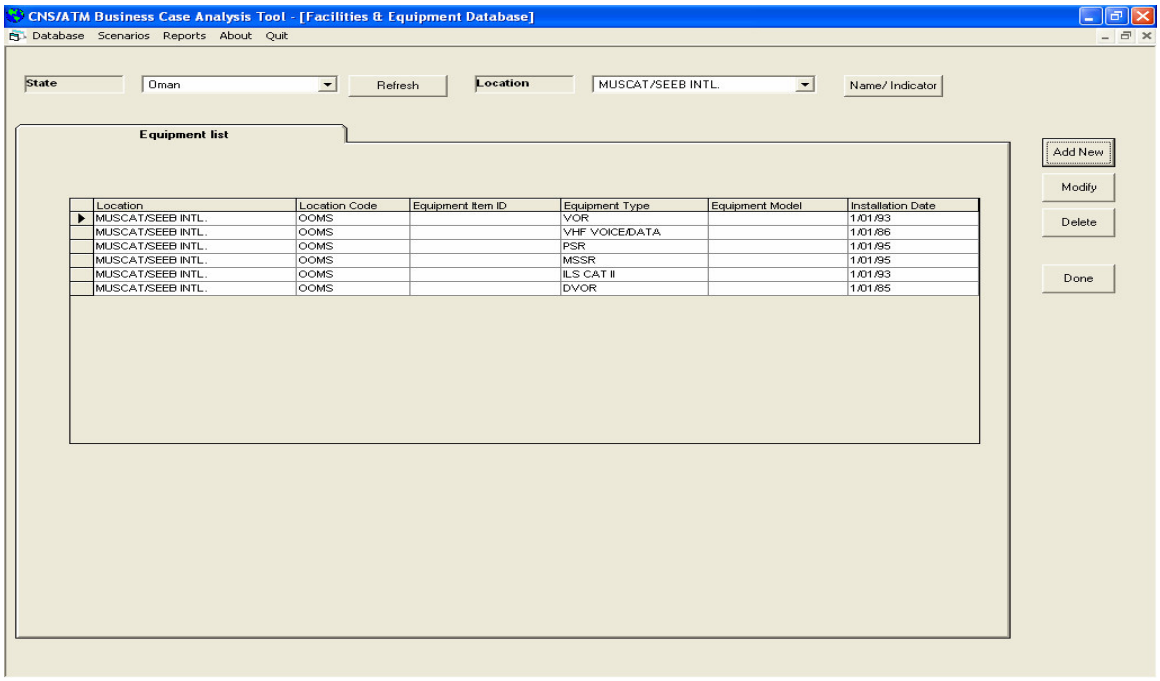
In the lower sub-window, Equipment Item ID is only a reference to the user and may or may not be entered. Move on to Equipment Type and select VOR from the pull-down list. Move on to Equipment Model. The specific name of the model is provided as an indication and again it may or may not be entered. Move on to Installation Date and fill the installation date 1/01/93 as shown in the following screen.



Click on the "**Save Equipment"** command button.

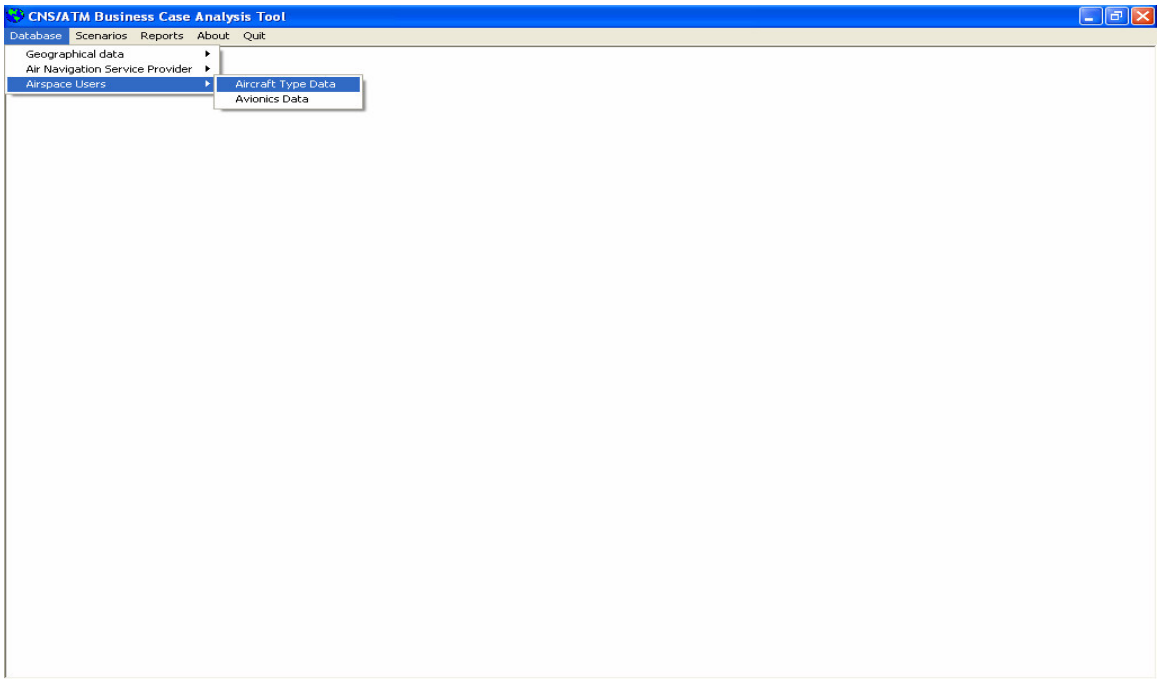


To enter data on additional equipment items, the "**Add New"** command button is invoked again, and the process is repeated until data for all equipment items is entered. After entering data for all conventional technology equipment items, the screen can be closed by clicking on the command button "**Done"**. The figure below summarizes the data entered for conventional technology equipment for this illustrative case, as given in Table 3 of the appendix.

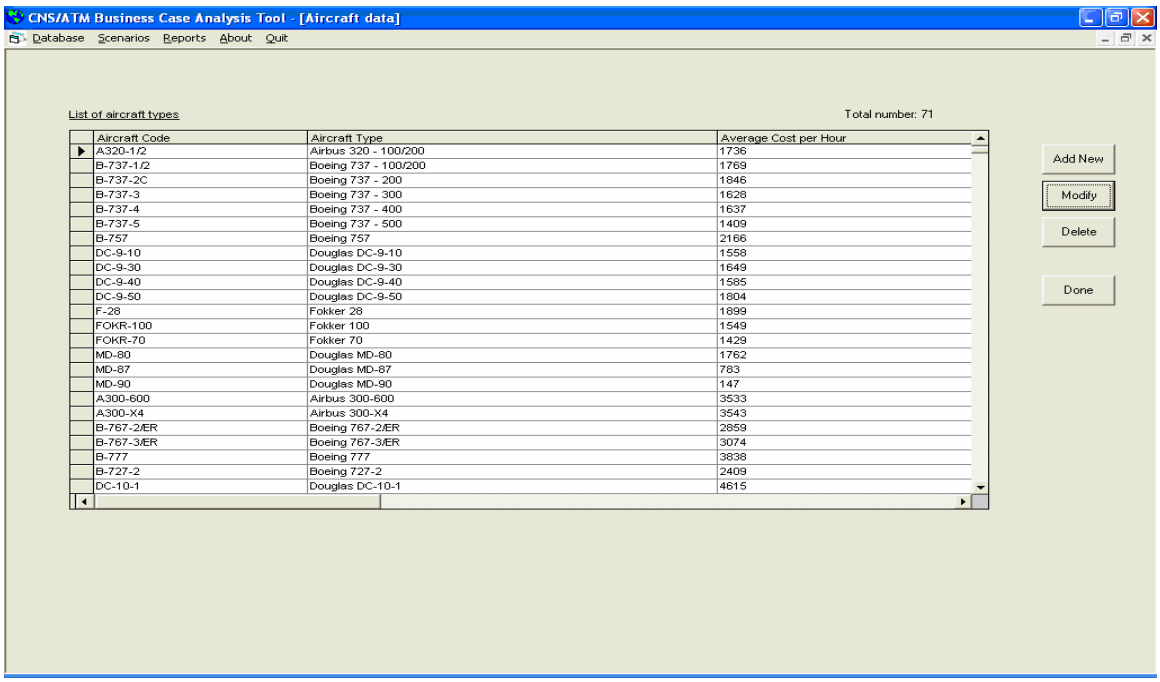

CNS/ATM Business Case Analysis Tool - [Facilities & Equipment Database]
Database
Scenarios
Reports
About
Quit
State
Oman
Refresh
Location
MUSCAT/SEEB INTL.
Name/ Indicator
Equipment list
Add New
Modify
Delete
Done
Location
Location Code
Equipment Item ID
Equipment Type
Equipment Model
Installation Date
MUSCAT/SEEB INTL. OOMS VOR 1/01/93
MUSCAT/SEEB INTL. OOMS VHF VOICE/DATA 1/01/86
MUSCAT/SEEB INTL. OOMS PSR 1/01/95
MUSCAT/SEEB INTL. OOMS MSSR 1/01/95
MUSCAT/SEEB INTL. OOMS ILS CAT II 1/01/93
MUSCAT/SEEB INTL. OOMS DVOR 1/01/85

CREATING OR UPDATING THE DATABASE FOR AIRSPACE USERS

To enter aircraft type and average cost per hour data for airspace users, click on the **database** menu item. Select **Airspace Users,** and then **Aircraft Type Data** as shown in the screen below**.**

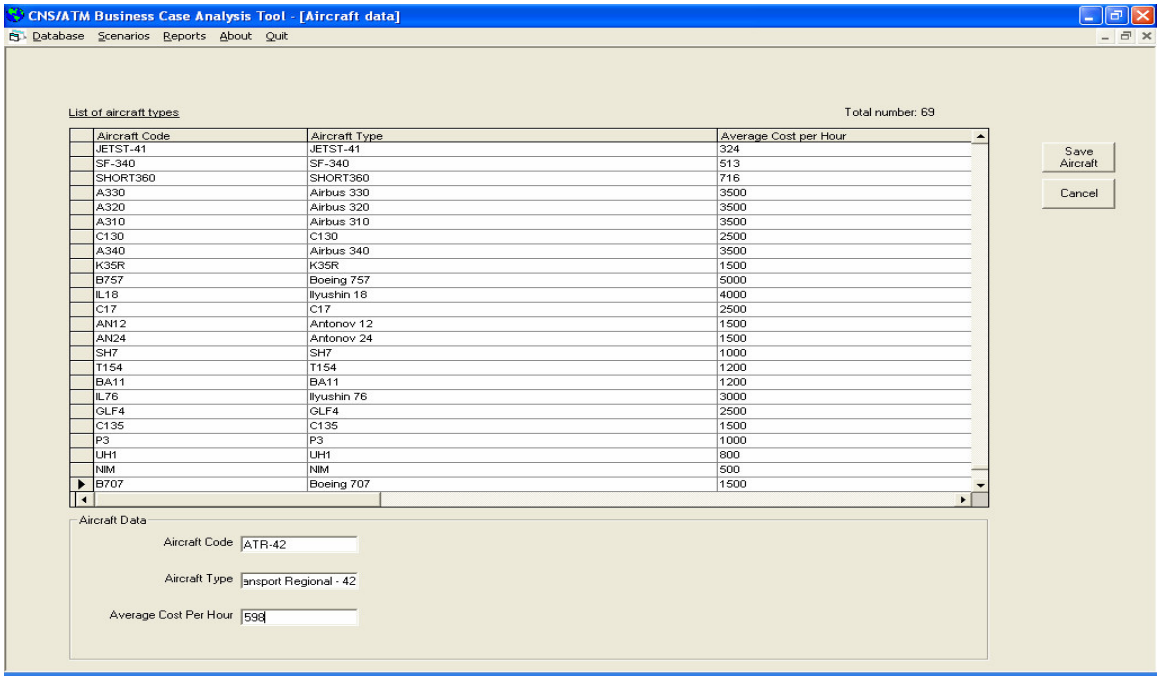


Click on the **Aircraft Type Data** item. A list with the columns: aircraft code, aircraft type and average cost per hour is displayed as shown in the following screen. This data is entered by invoking the "**Add New**" command button.

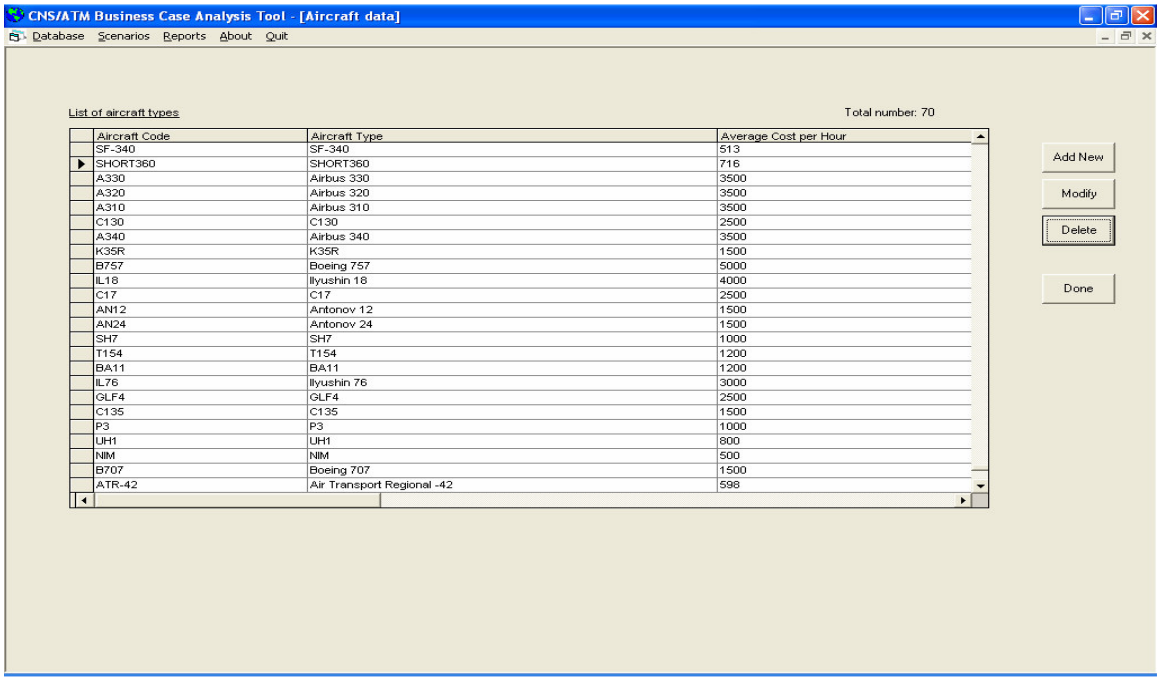


Aircraft Code	Aircraft Type	Average Cost per Hour
A320-1/2	Airbus 320 - 100/200	1736
B-737-1/2	Boeing 737 - 100/200	1769
B-737-2C	Boeing 737 - 200	1846
B-737-3	Boeing 737 - 300	1628
B-737-4	Boeing 737 - 400	1637
B-737-5	Boeing 737 - 500	1409
B-757	Boeing 757	2166
DC-9-10	Douglas DC-9-10	1558
DC-9-30	Douglas DC-9-30	1649
DC-9-40	Douglas DC-9-40	1585
DC-9-50	Douglas DC-9-50	1804
F-28	Fokker 28	1899
FOKR-100	Fokker 100	1549
FOKR-70	Fokker 70	1429
MD-80	Douglas MD-80	1762
MD-87	Douglas MD-87	783
MD-90	Douglas MD-90	147
A300-600	Airbus 300-600	3533
A300-X4	Airbus 300-X4	3543
B-767-2/ER	Boeing 767-2/ER	2859
B-767-3/ER	Boeing 767-3/ER	3074
B-777	Boeing 777	3838
B-727-2	Boeing 727-2	2409
DC-10-1	Douglas DC-10-1	4615

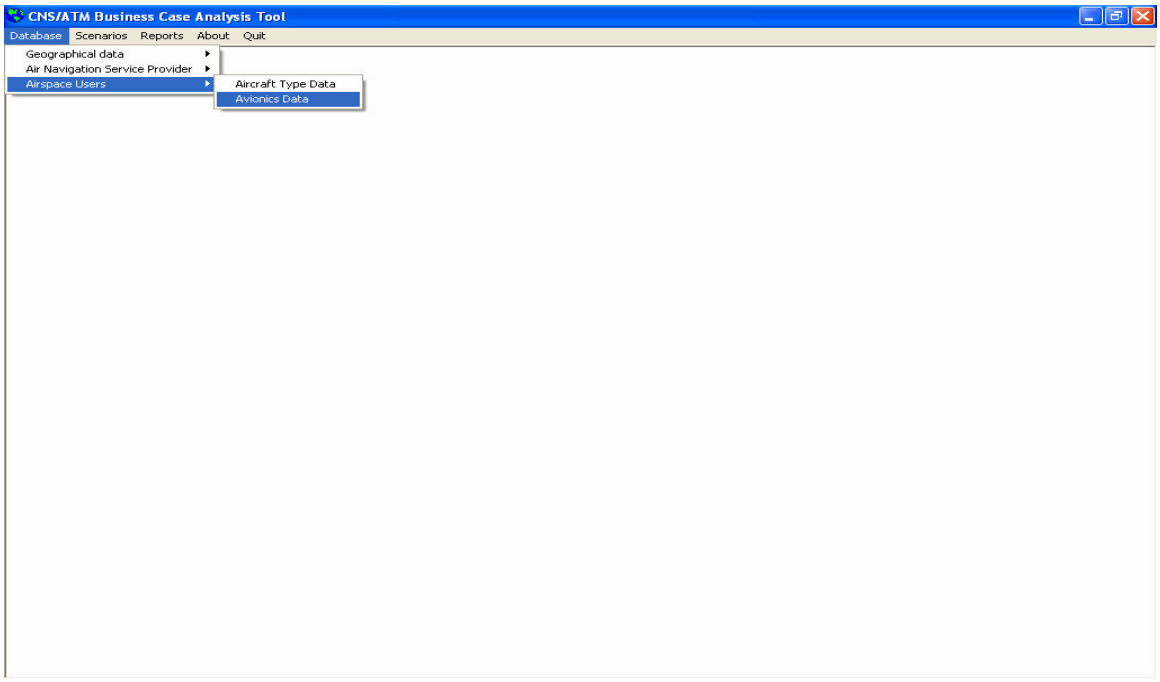
Click on the "**Add New"** command button. Enter ATR-42 for Aircraft Code, Air Transport Regional - 42 for Aircraft Type and 598 for Average Cost per Hour.



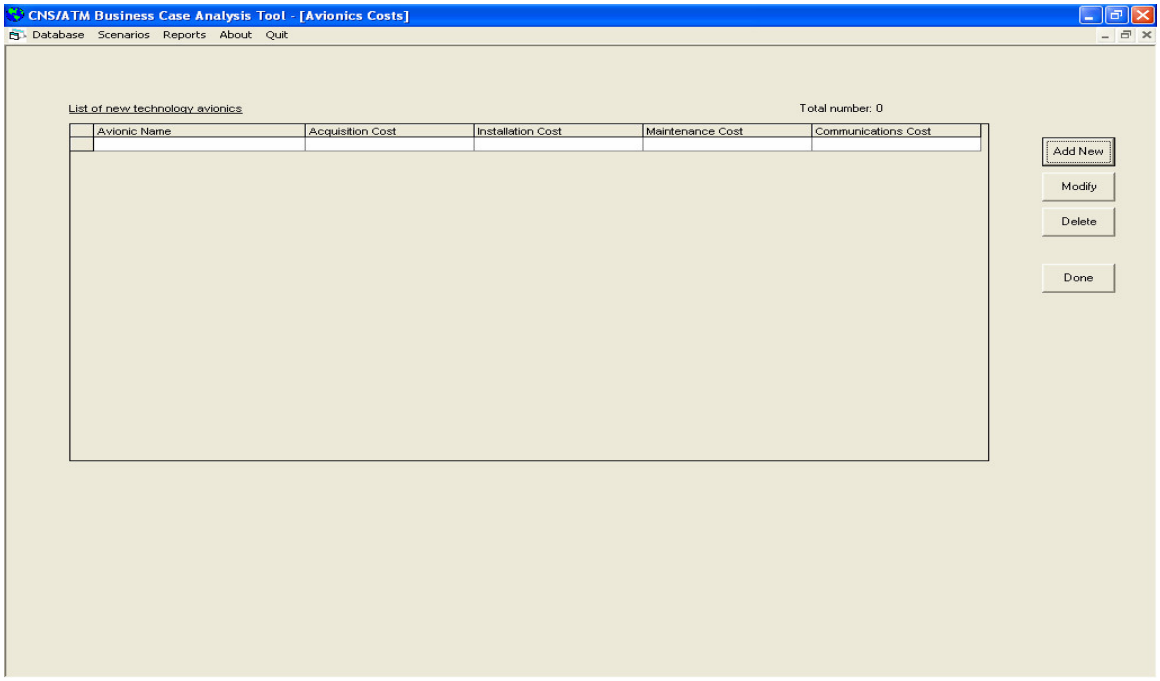
Click on "**Save Aircraft"** command button. Click on the "**Done"** command button to exit this option.



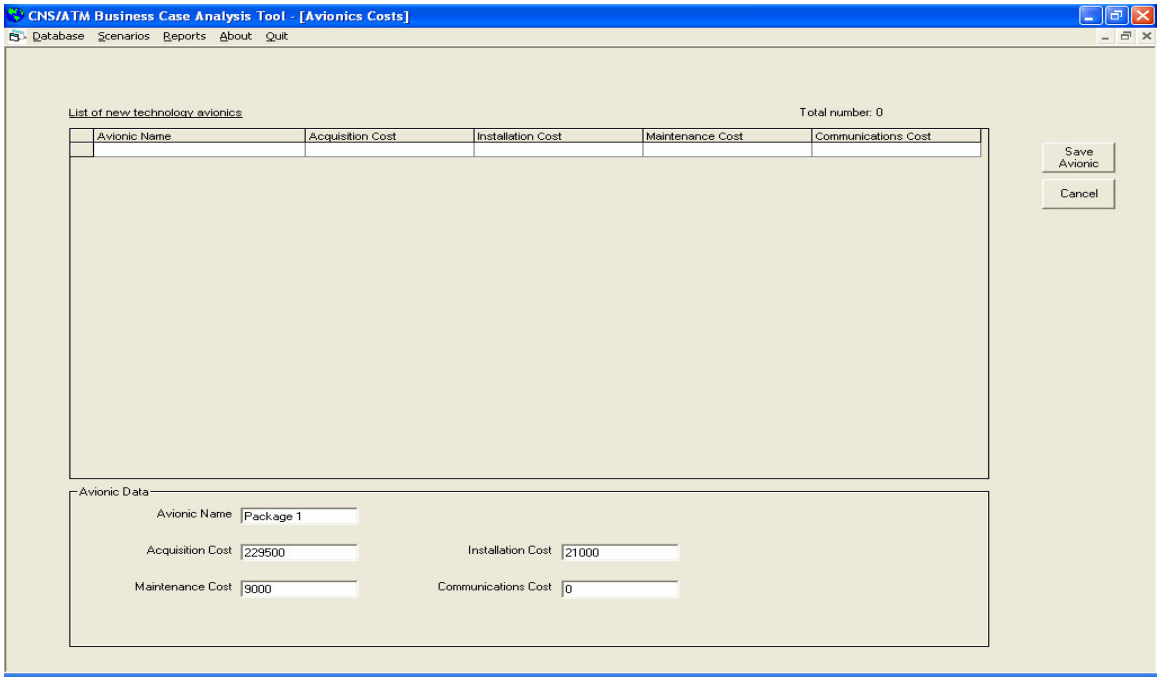
To enter new technology avionics and their associated costs (acquisition cost, installation cost, maintenance cost and communication cost), click on the **database** menu item. Select **Airspace Users,** and then **Avionics Data** as shown in the following screen.



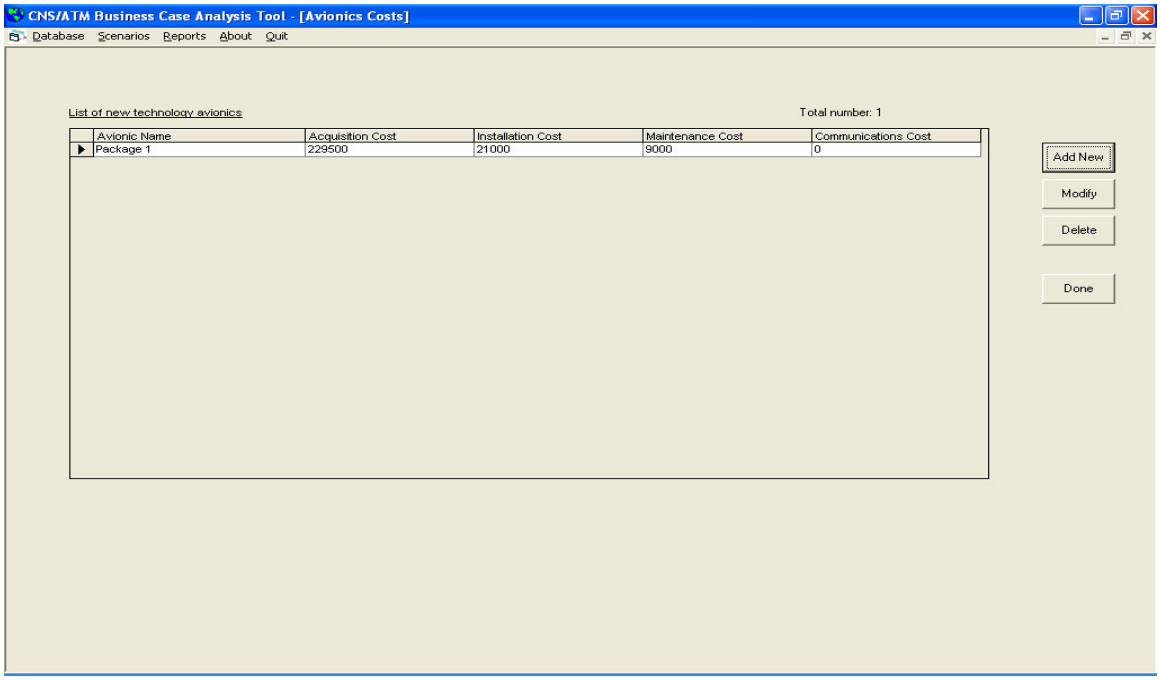
Click on **Avionics Data** item.



Click on the "**Add New"** command button. Enter the name of avionics or package consisting of a set of avionics as the case may be. In the present case, a set of avionics referred to as Package1, as described in table 4 of the appendix, is entered with an acquisition cost of 229500, an installation cost of 21000, an annual maintenance cost of 9000 and a communication cost equal to 0, as shown in the screen below.

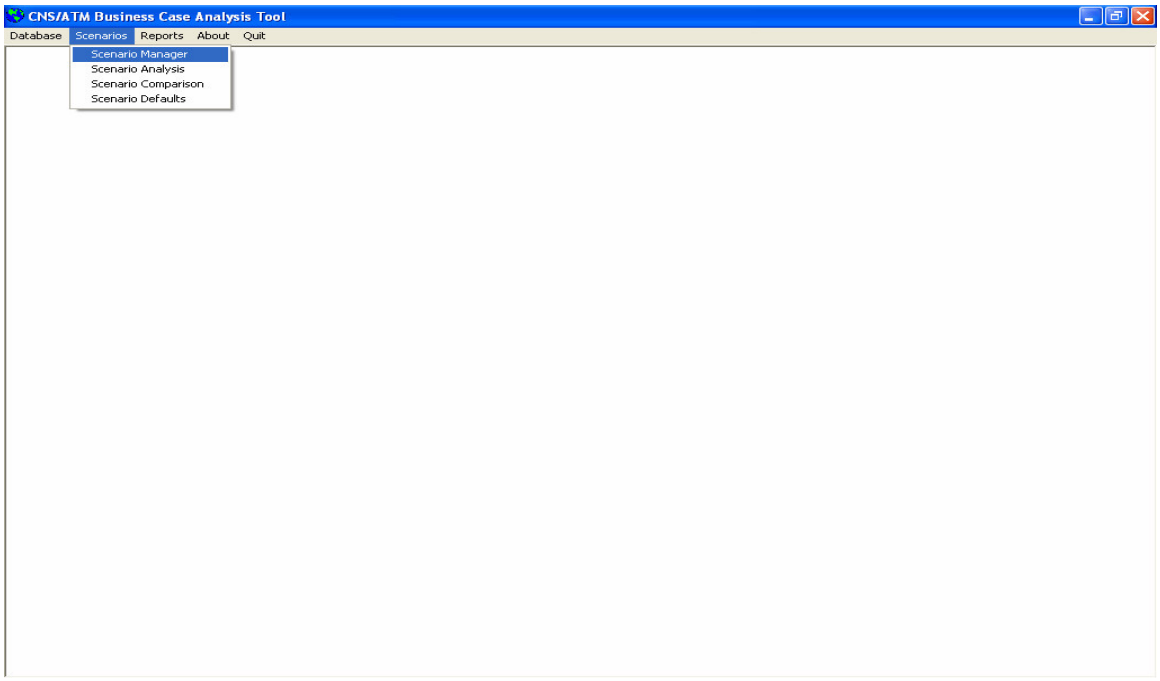


Click on the "**Save Avionics"** command button. Additional avionics items can also be entered by using the "**Add New"** command button. Click on the command button "**Done"** to exit.

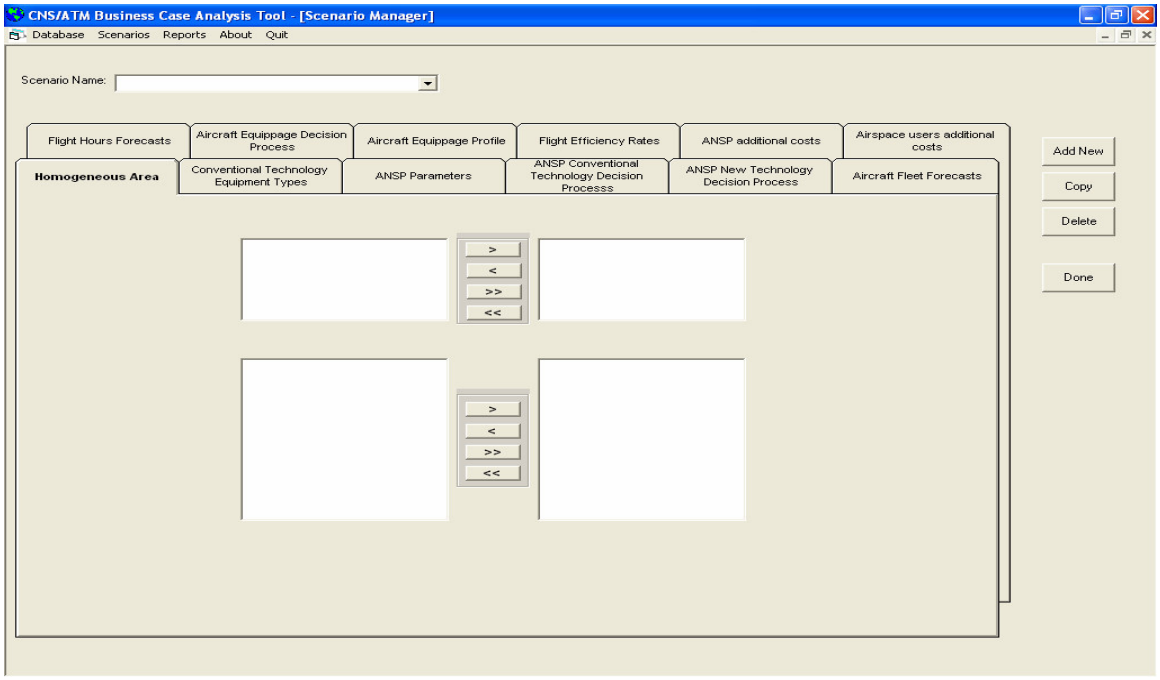


SCENARIO BUILDING PROCESS

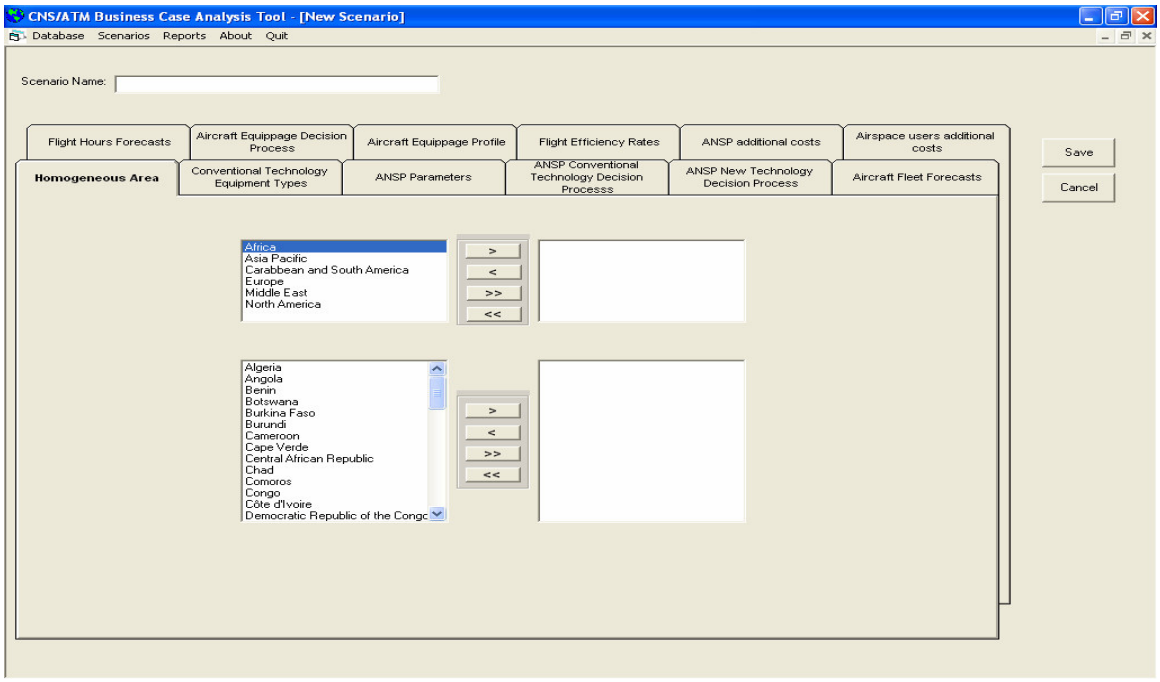
Click on the **Scenarios** menu item. Then, select **Scenario Manager** from the pull down list as shown in the screen below.



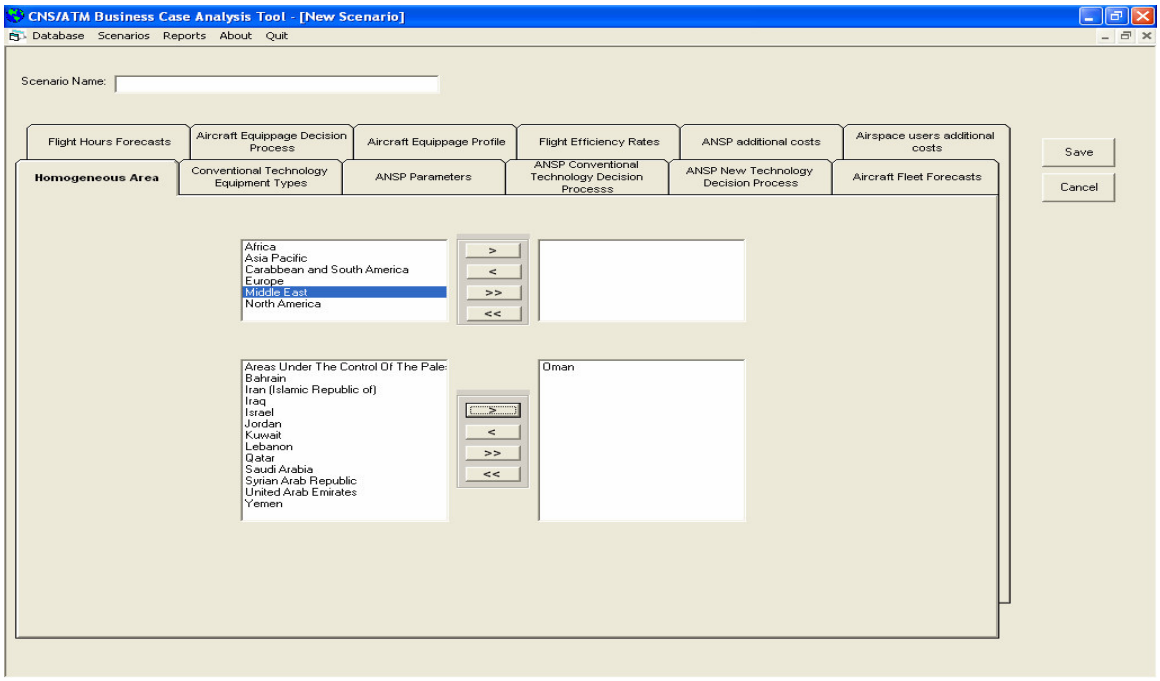
The following screen will then appear.



Click on the top right side command button "**Add New**". A list of world regions pops up in the upper left box of the **Homogeneous Area** tab as shown in the following screen. A list of States is also displayed in the lower box.

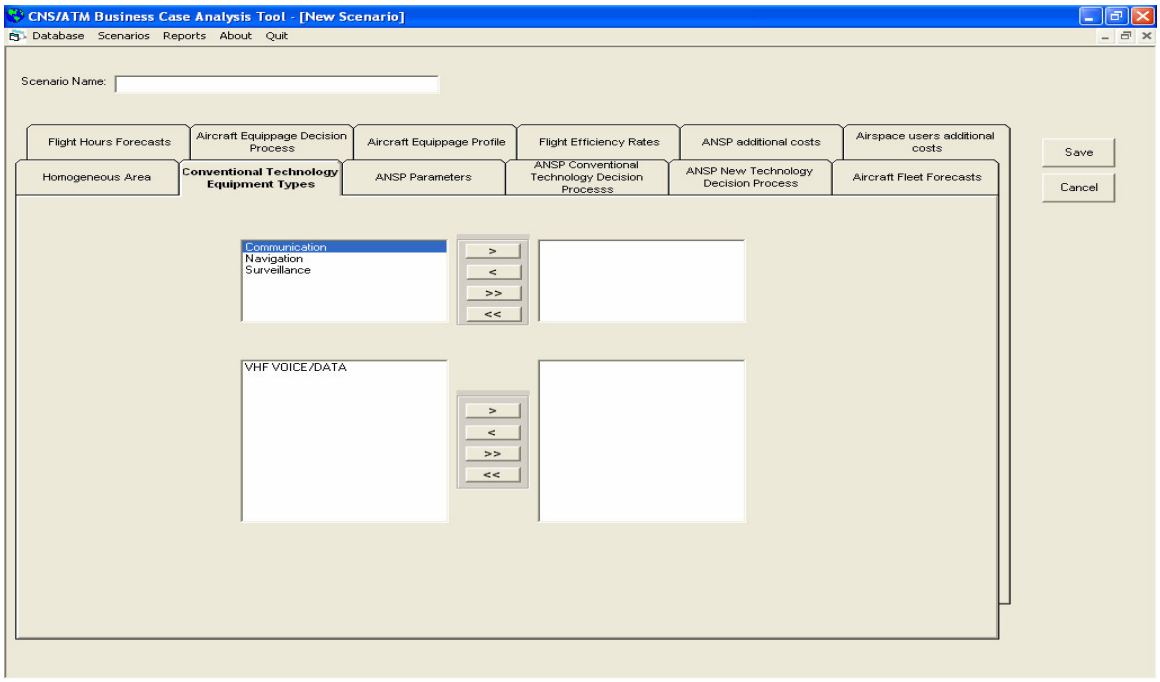


Since the analysis is for Oman, first highlight the **Middle East** region from the upper box and secondly **Oman** from the lower box. Select Oman by clicking the carry forward button "**>" . Oman** will now be displayed in the corresponding right side box as shown in the screen below.

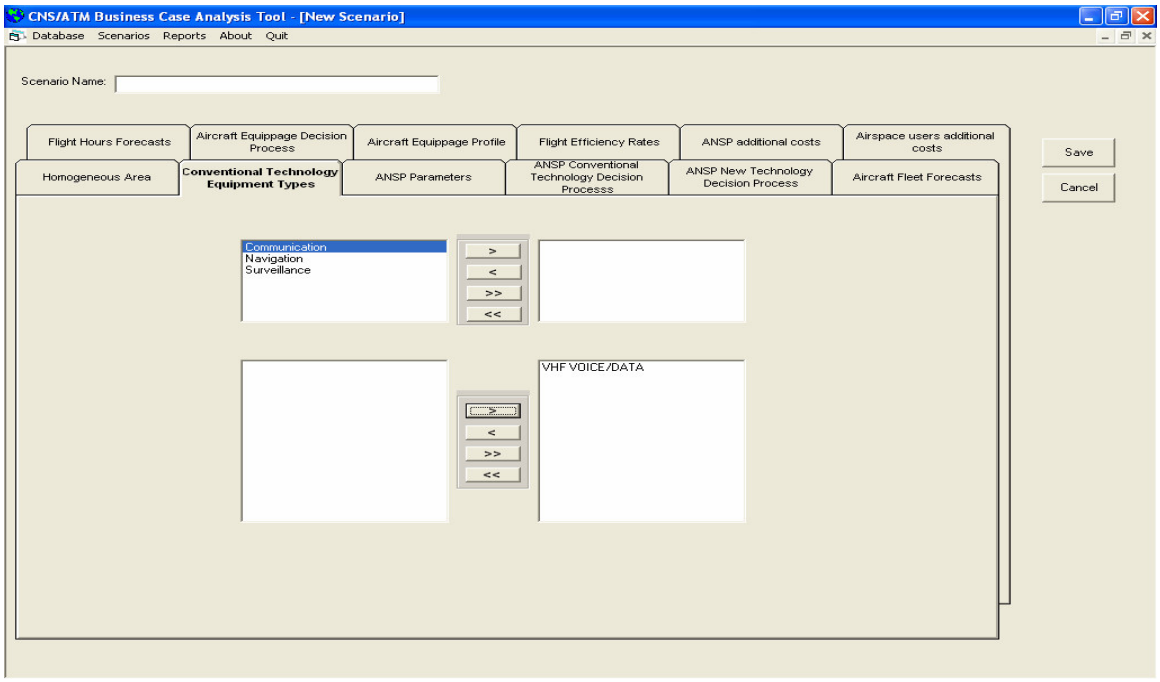


Scenario for Conventional Technology Equipment Type

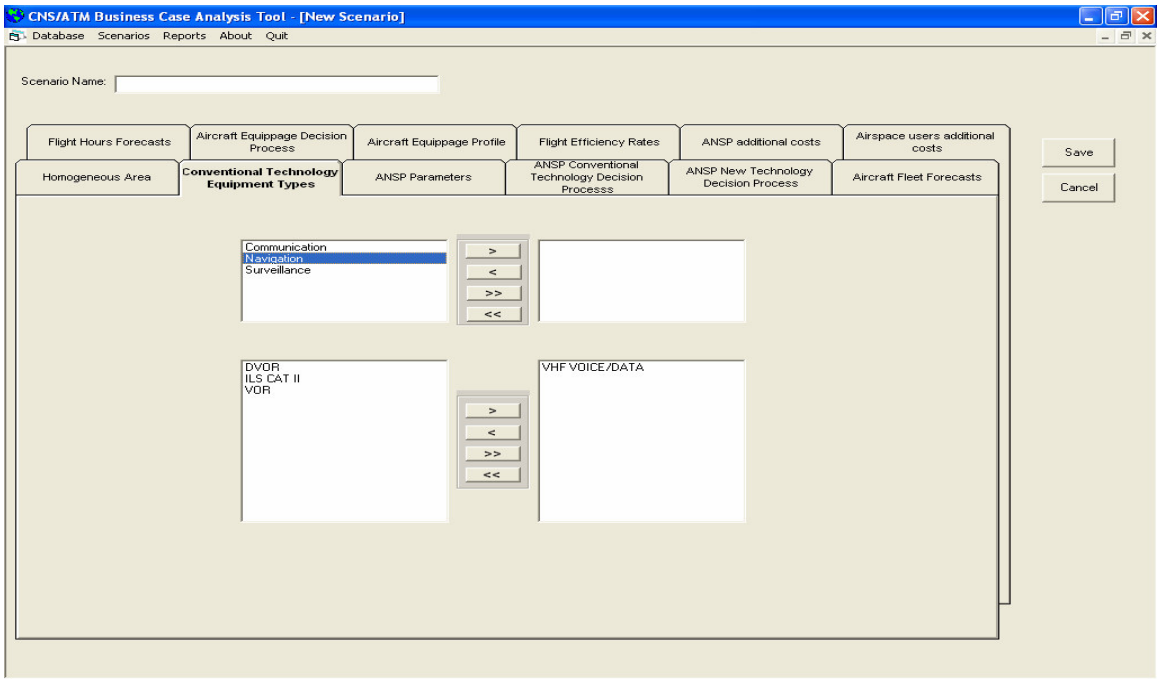
Click on the tab **Conventional Technology Equipment Type.** Select **Communication** from the upper window. The equipment type **VHF VOICE/DATA** is displayed in the lower window. Select this item.



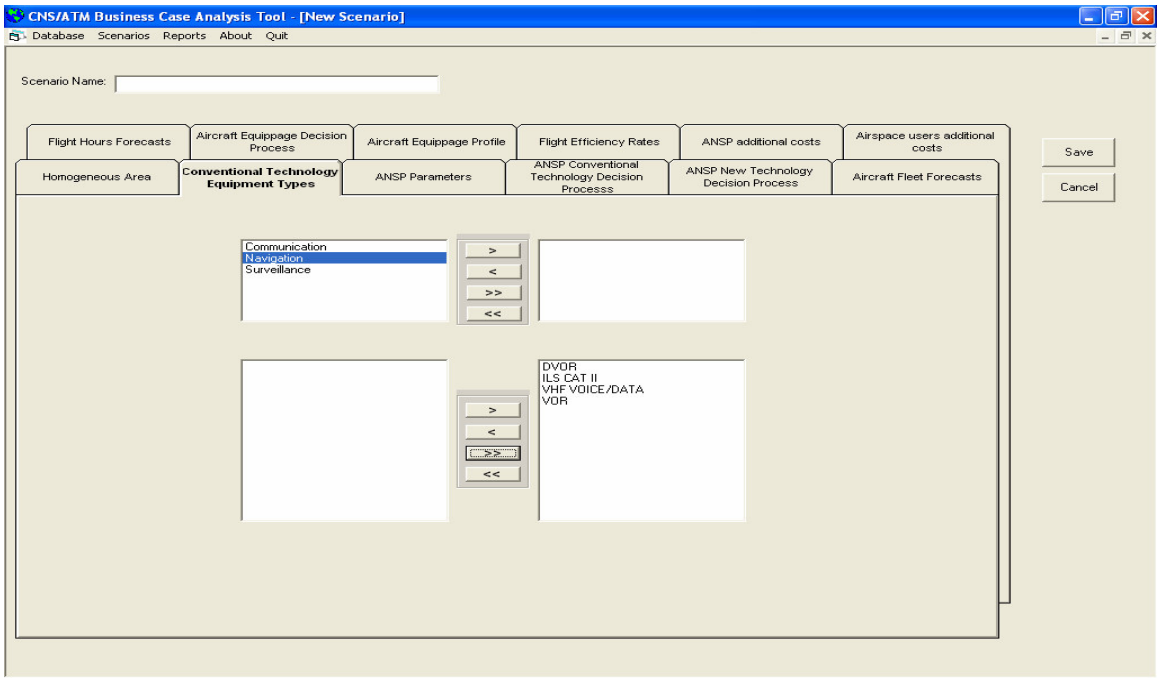
Click at carry forward button "**>**" **. VHF VOICE/DATA** will now be displayed in the right lower selection window for conventional technology equipments.



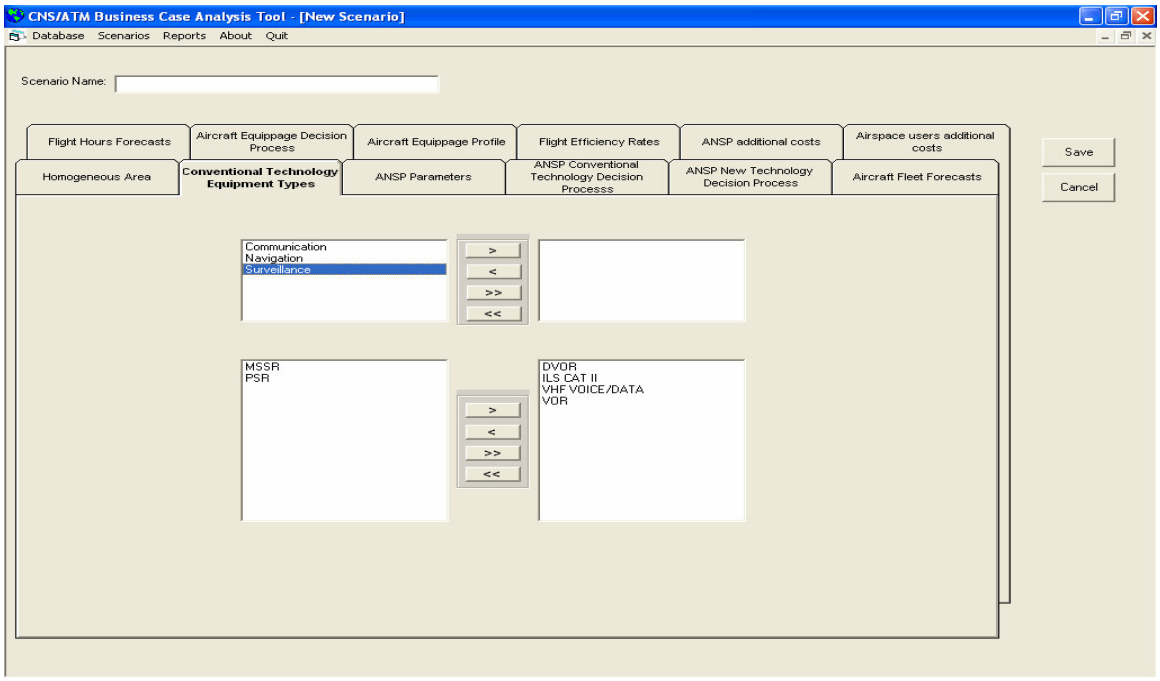
Click on **Navigation** in the left upper window. All navigation equipment (VOR, ILS Cat II and DVOR) appear in the lower left window.



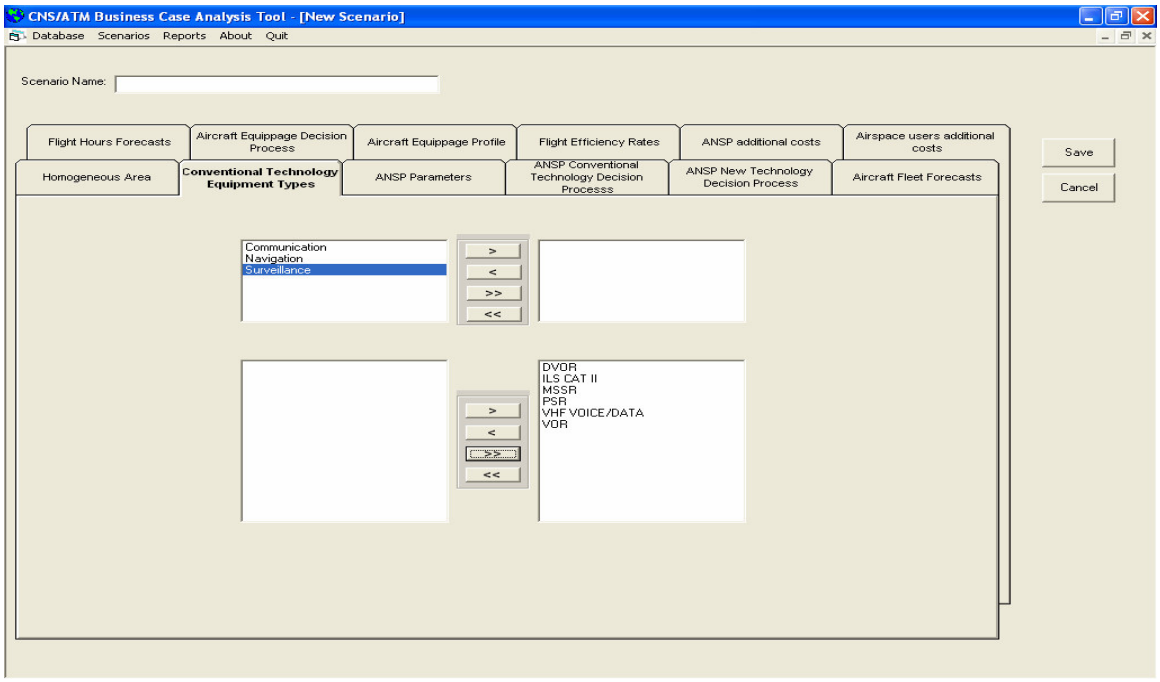
Select all of them one by one and post in the lower right window using carry forward button "**>", or ">>".**



Click on **Surveillance** in the left upper window. All surveillance equipment (PSR and MSSR) appear in the lower left window.

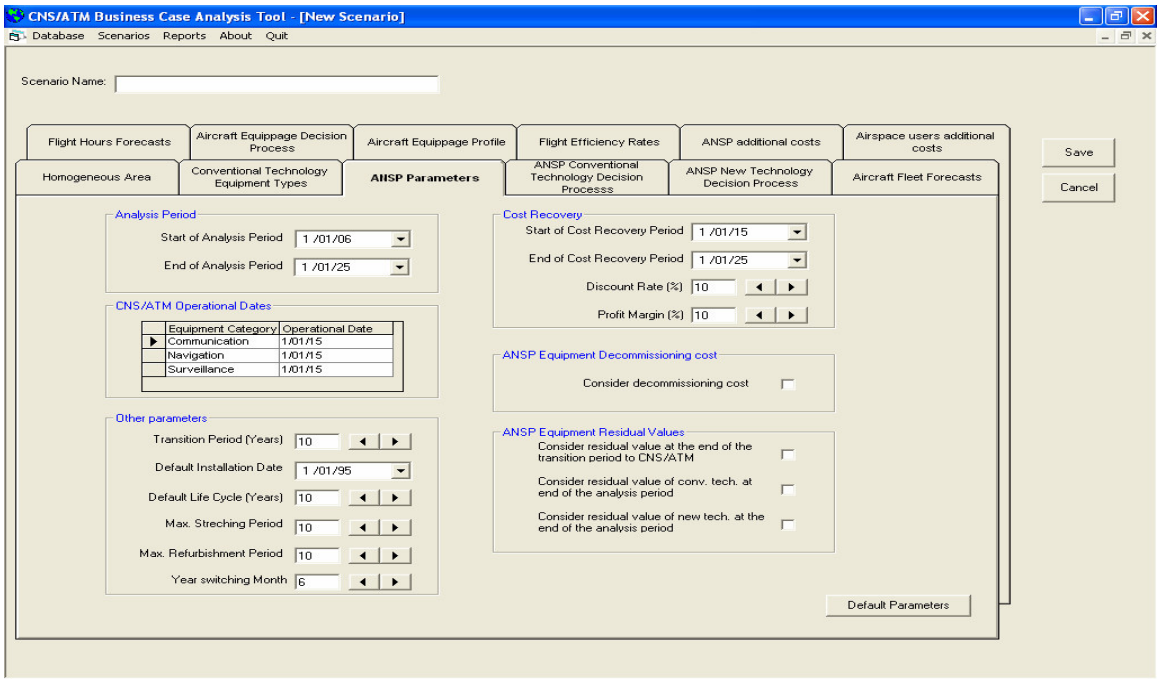


Select all of them one by one and post in the lower right window using carry forward button "**>", or ">>".** This completes the process of inclusion of all conventional technology equipments in the analysis.



Scenario for ANSP Parameters

Click on the tab **ANSP Parameters.** The default values appear for each block of scenario parameters: Analysis Period, CNS/ATM operational Dates, Other parameters, Cost Recovery Period, ANSP Equipment Decommissioning cost and ANSP Equipment Residual values.



From Table 5 in the appendix:

- Enter **1/01/06** as Start Date of Analysis, **1/01/25** as End Date of Analysis in Analysis Period block.

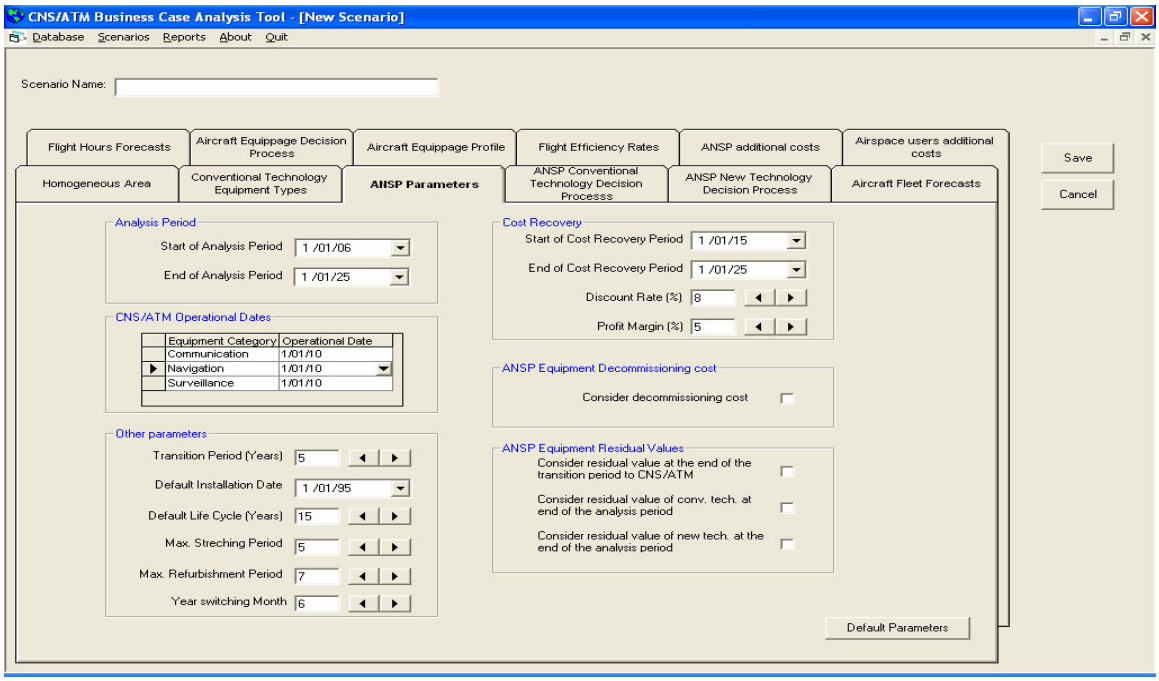
- Enter **1/01/10** as Operational Date for each of the Equipment Category in CNS/ATM operational Dates block.

- Enter **5** for Transition Period, **5** for Maximum Stretching Period, **7** for Refurbishment Period and **6** for Year switching Month in Other parameter block.

- Enter **1/01/10** for Start of Cost Recovery Period, **1/01/25** for End of Cost Recovery Period, **8** for Discount Rate (%) and **5** for Profit (%) in Cost Recovery block.

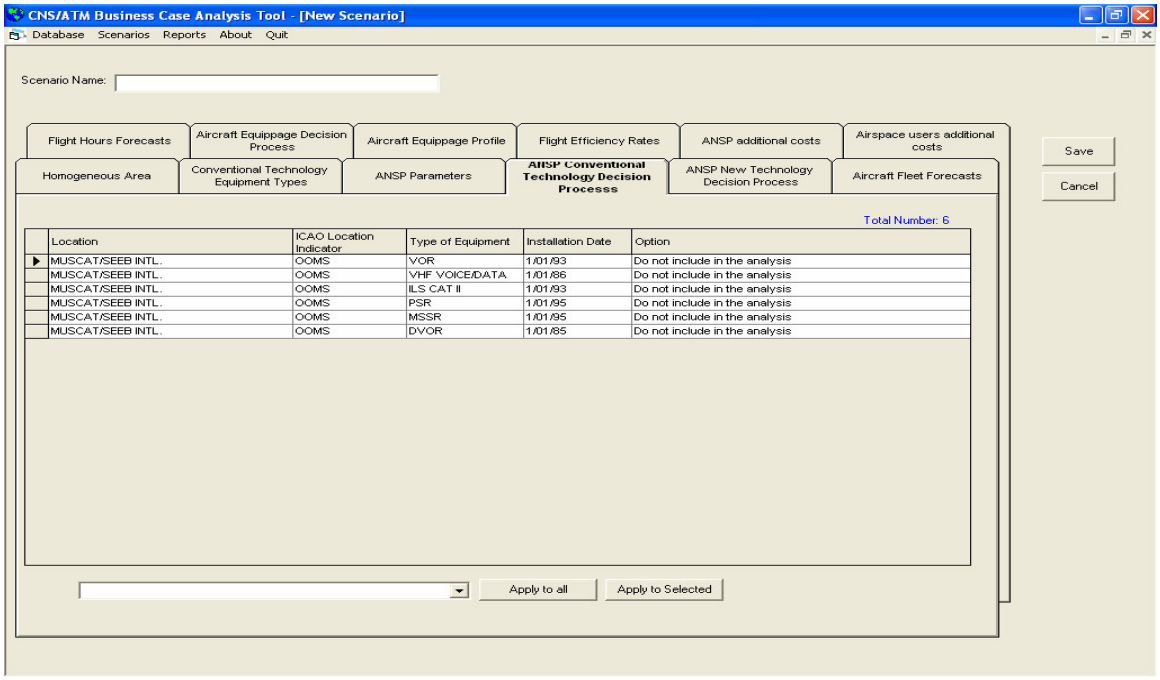
As the decision in this scenario is not to consider decommissioning cost, do not check the box in ANSP Equipment Decommissioning cost block.

As the decision in this scenario is not to consider the residual values of conventional and new technology equipment in the analysis, do not check the three boxes in ANSP Equipment Residual values block. The following screen shows the selected ANSP parameters.

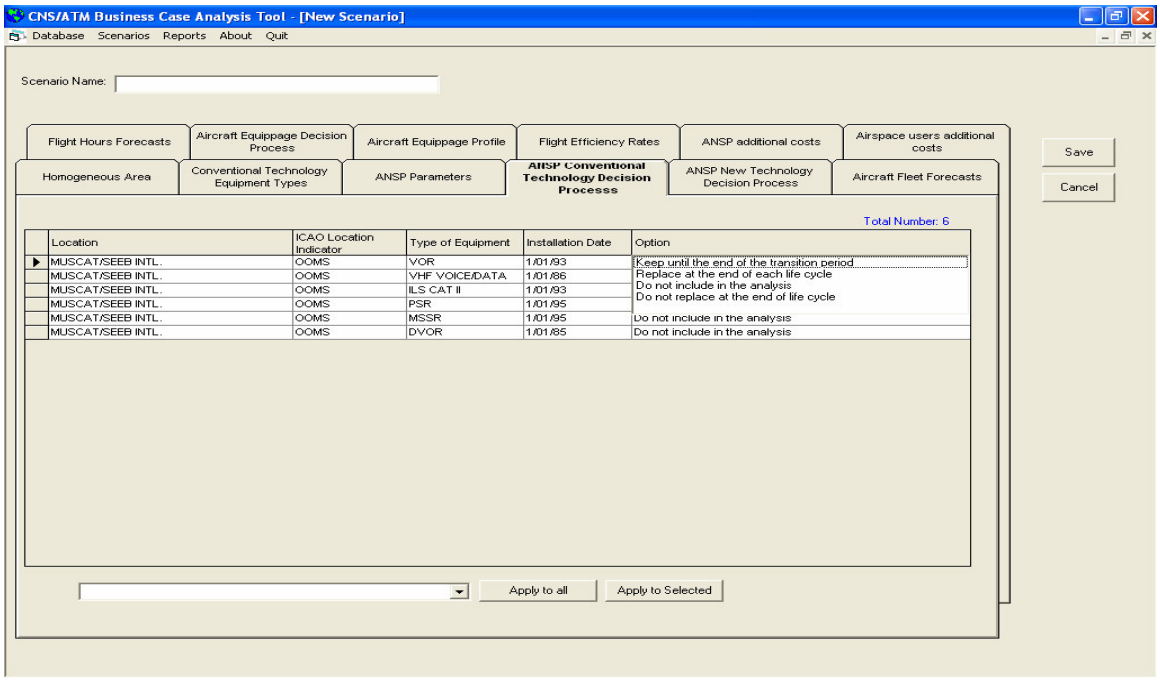


Scenario for ANSP Conventional Technology Decision Process

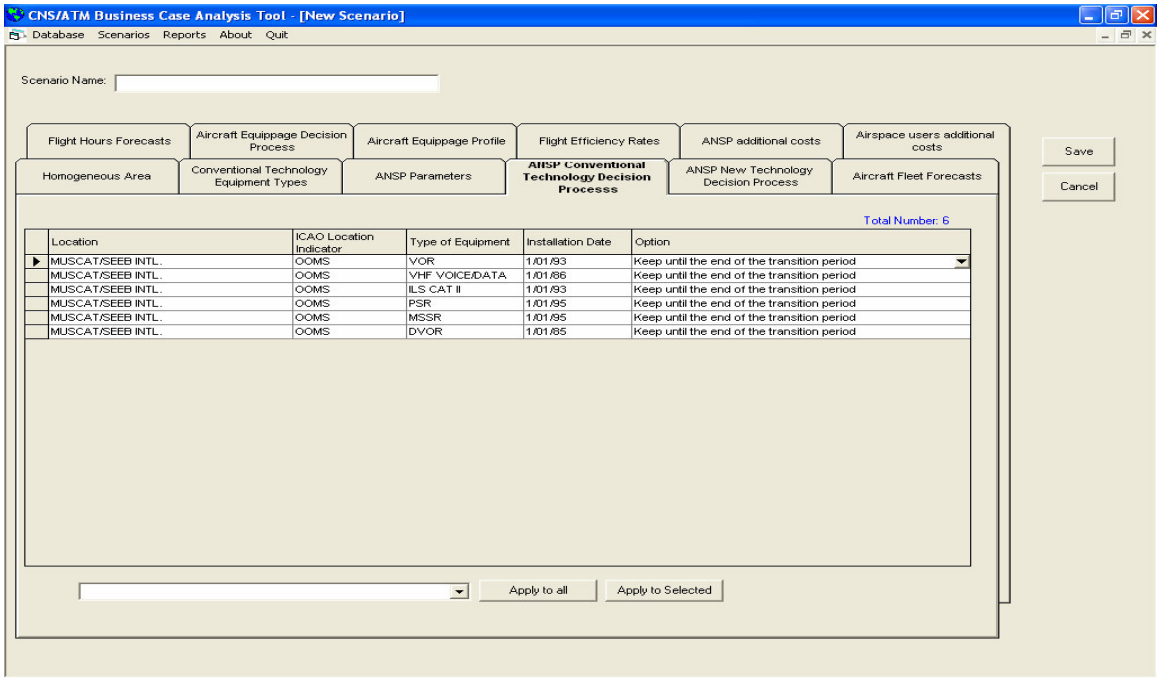
Click on the tab **ANSP Conventional Technology Decision Process.**



Click on the first cell in the **Option** column. Select the option "*Keep until the end of transition period"* from the four given options.

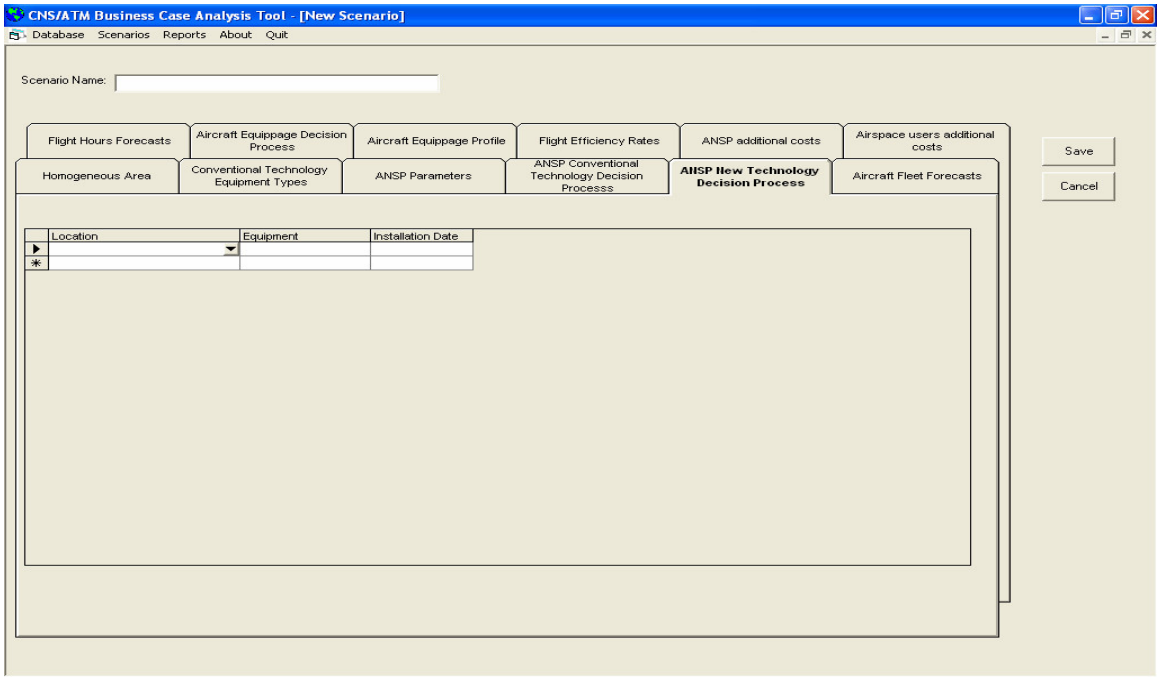


Double click on the selected option "*Keep until the end of transition period*". Repeat this for all other equipments items.

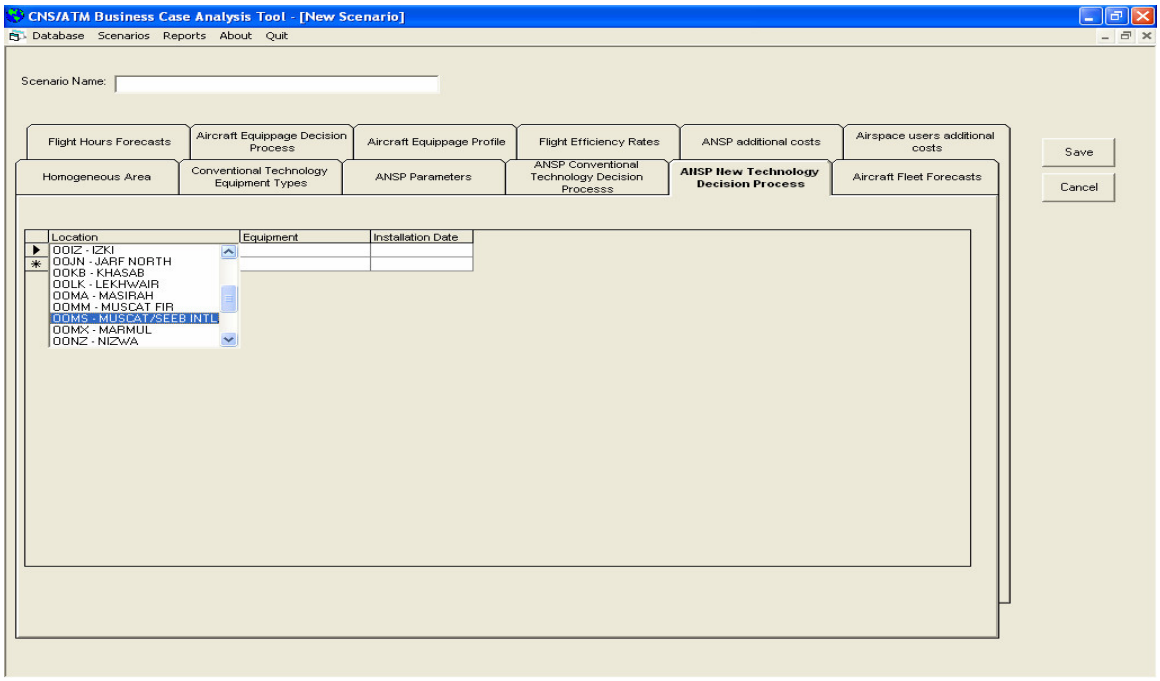


Scenario for ANSP New Technology Decision Process

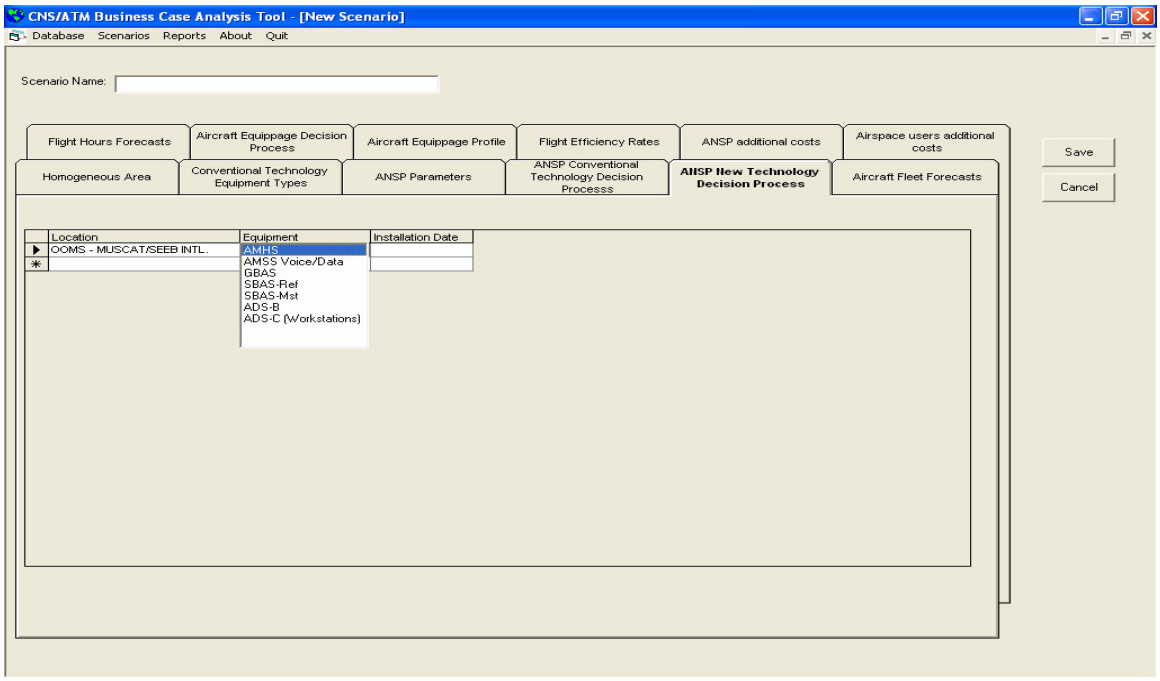
Click on the tab **ANSP New Technology Decision Process.**



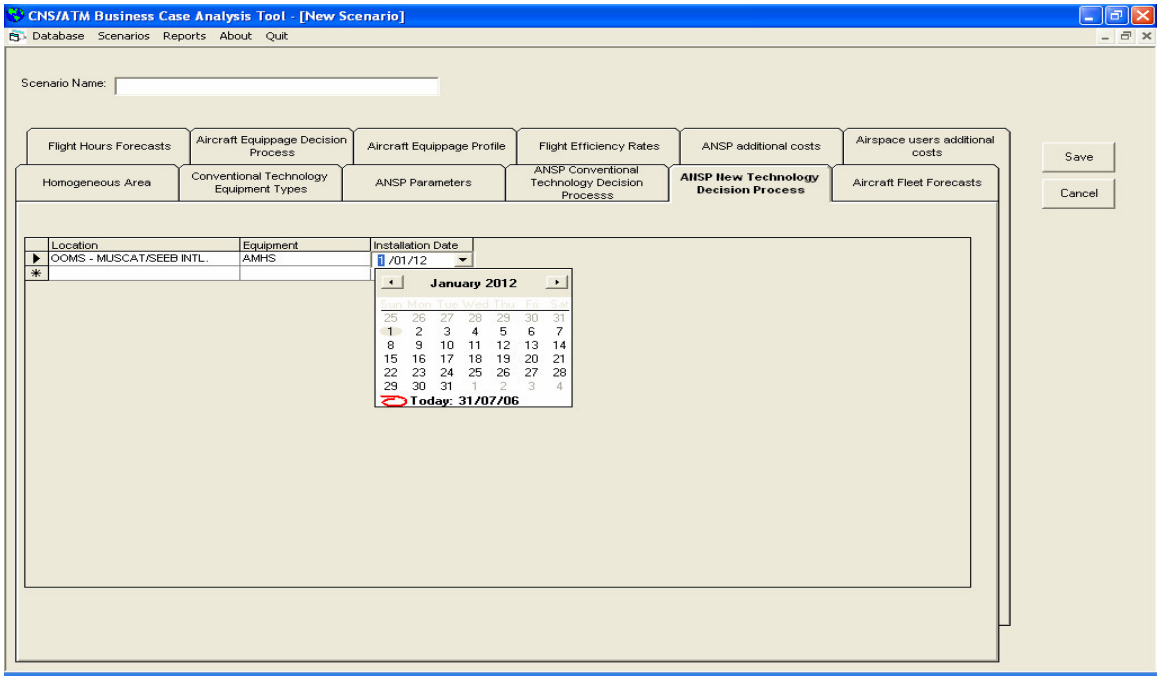
Click on the pull down button in the **Location** column.



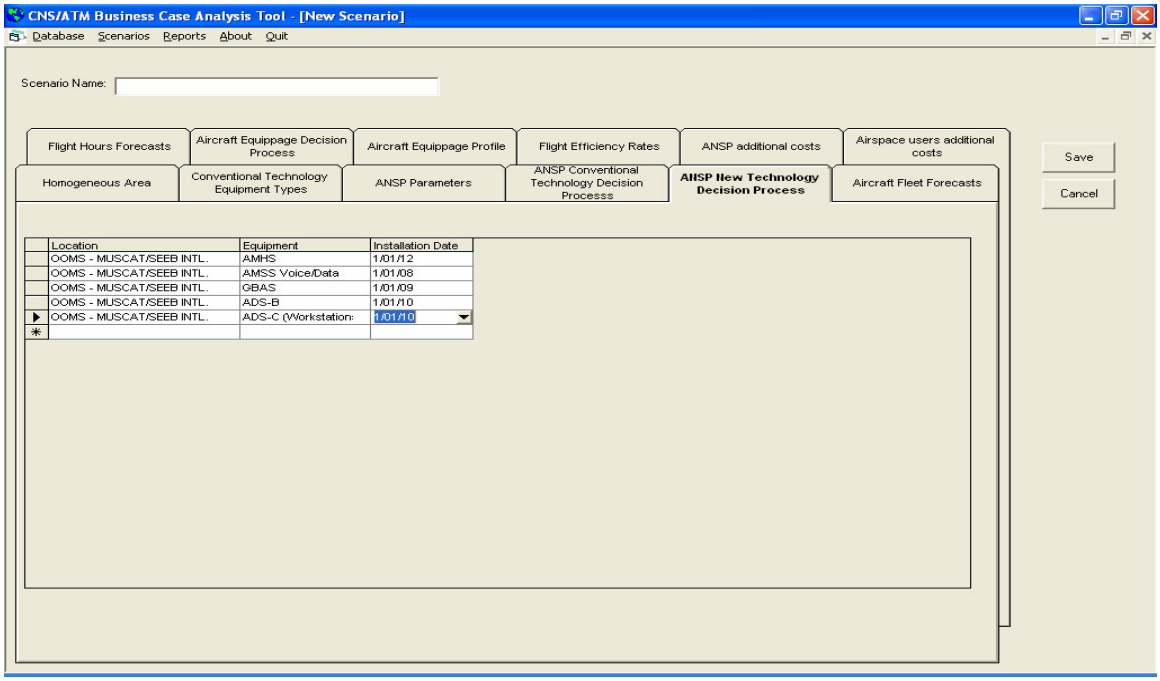
Select **MUSCAT/SEEB INTL** by clicking on it. Go to the Equipment column and similarly select **AMHS.**



Go to **Installation Date** column. Enter **1/01/12** (see Table 6 of the appendix).

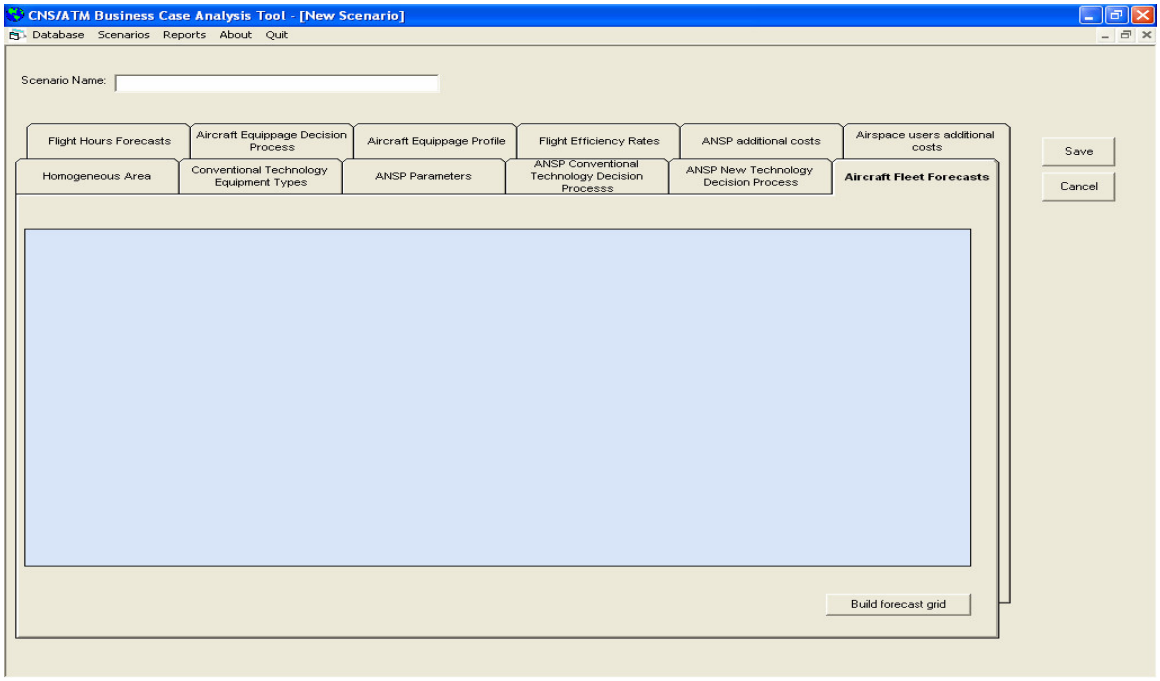


Repeat this process for all other new technology equipment items.

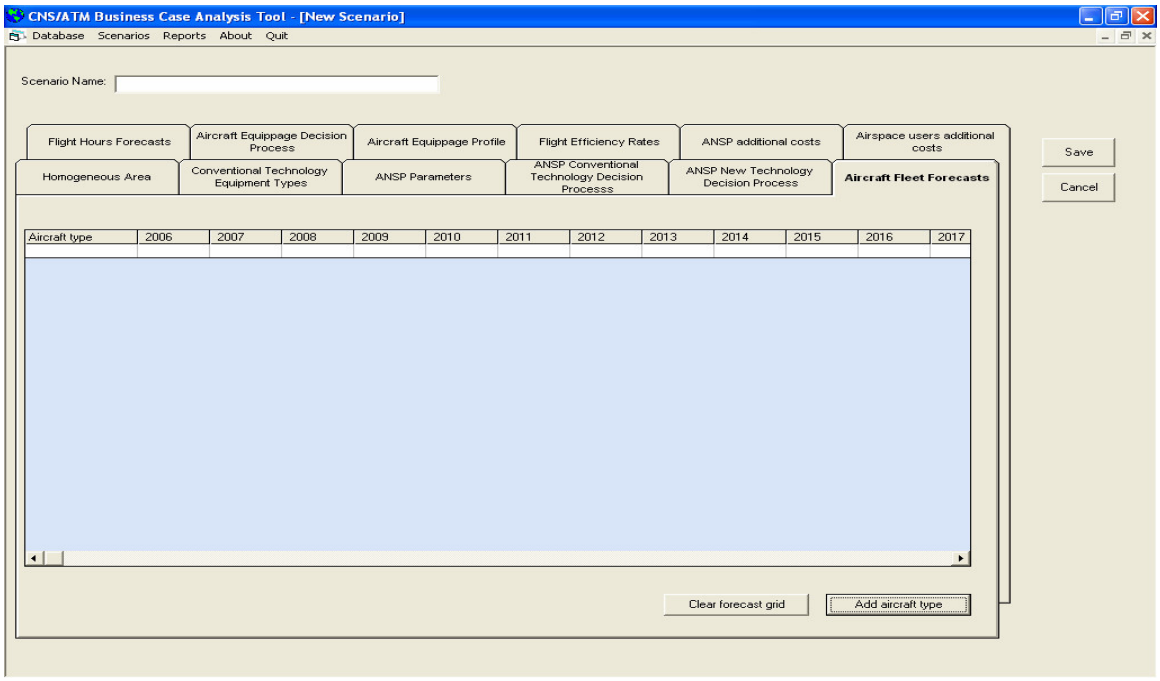


Scenario for Aircraft Fleet Forecast

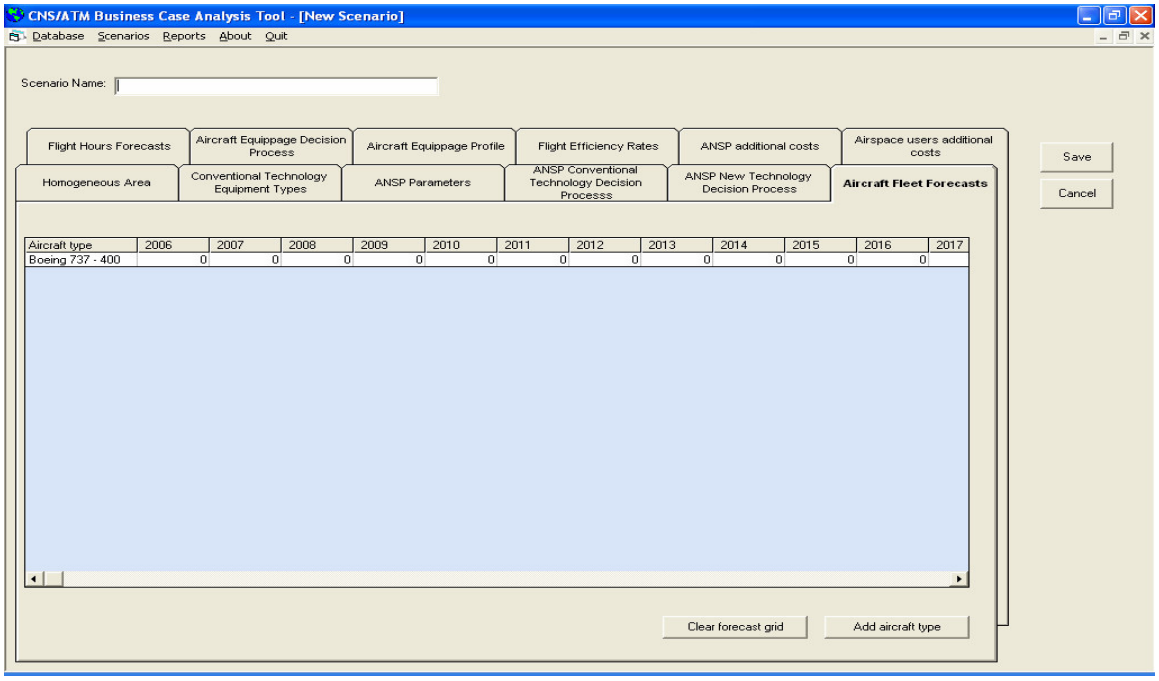
Click on the tab **Aircraft Fleet Forecast.**



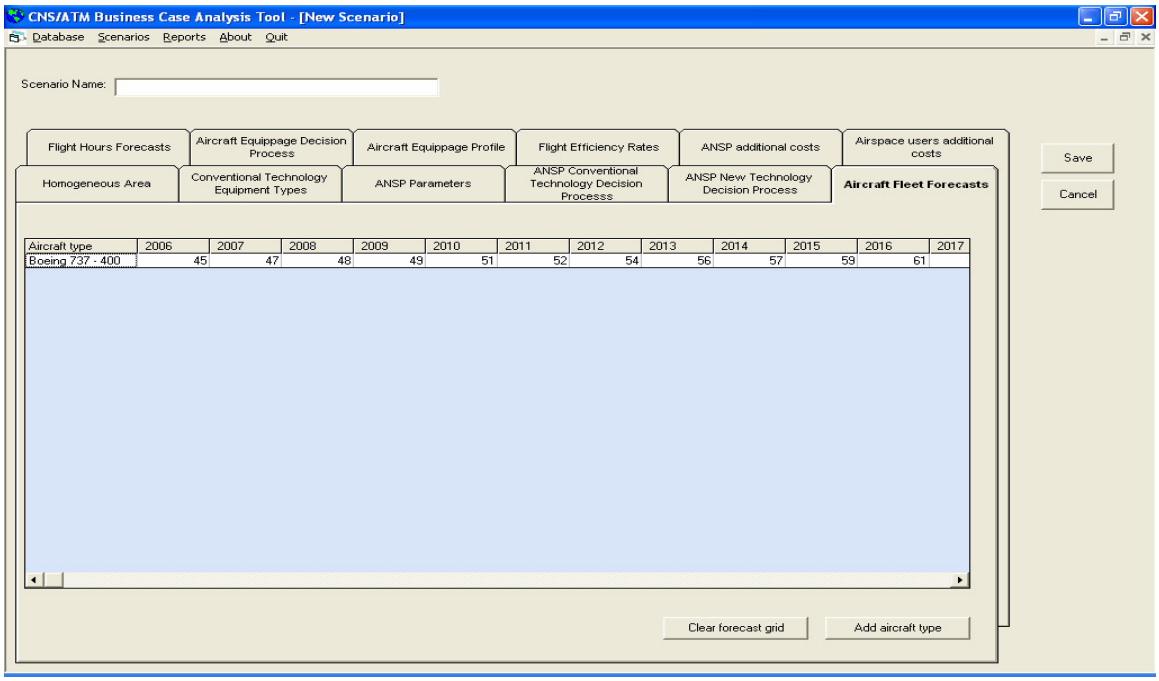
Click on the "**Build forecast grid"** command button in the right lower corner. An empty row for entering the aircraft type and the corresponding number of aircraft forecast for each year of the analysis period (2006 to 2025) is displayed. The first command button at the lower right corner can be used to clear the data entered in the grid, and the second command button can be used to enter data for additional aircraft types, as given in Table 7 of the appendix.



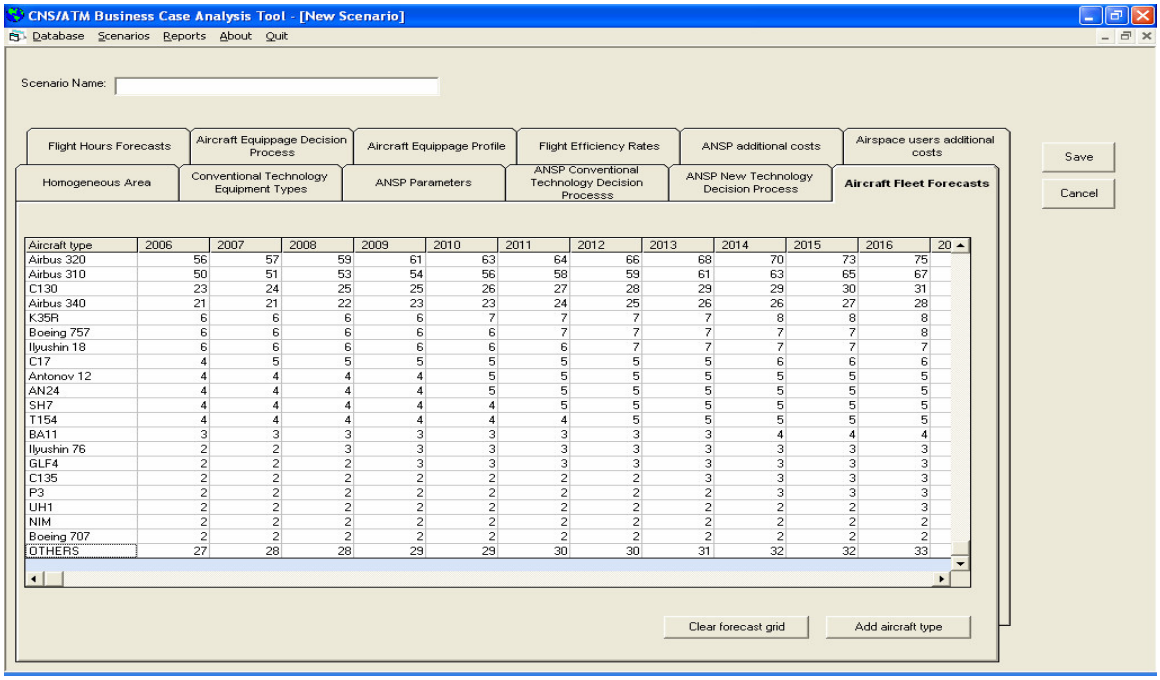
First select the aircraft type (Boeing 737-400) from the pull down list and click on it.



Now enter the corresponding number of aircraft in the fleet for each of the years 2006 to 2025. The next screen shows the grid after the fleet forecast for the aircraft type Boeing 737-400 is entered.

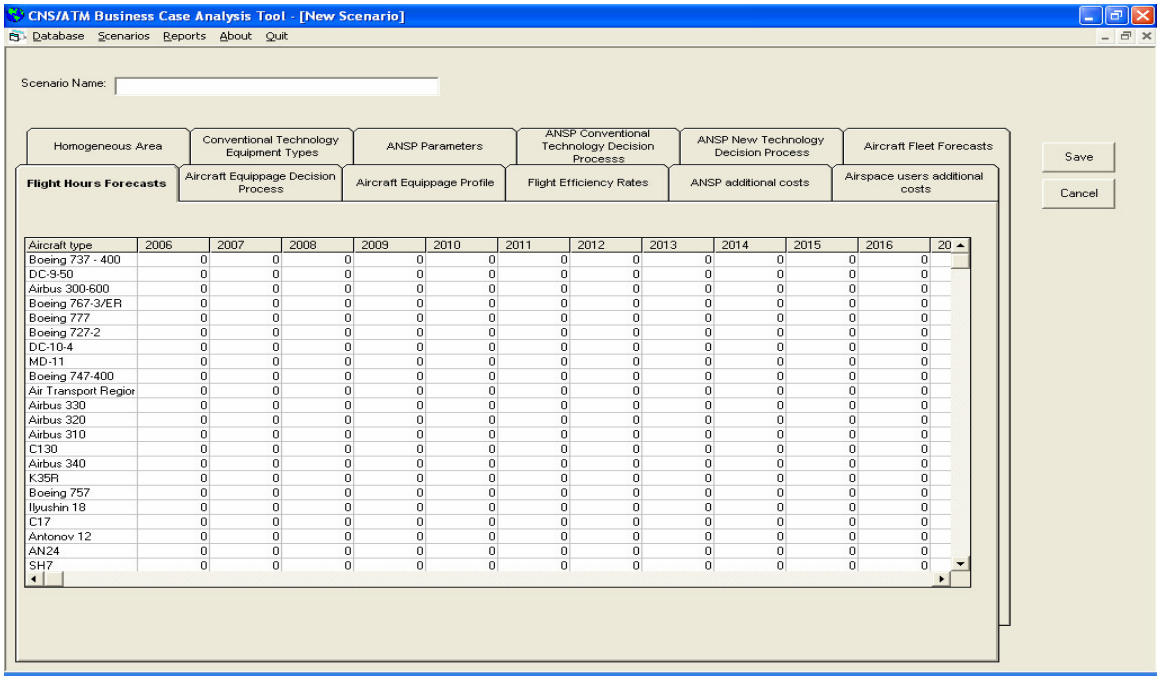


Click on the "**Add aircraft type"** command button. An additional row will be displayed and the same procedure as before is followed until all the data is entered, as illustrated in the next screen.



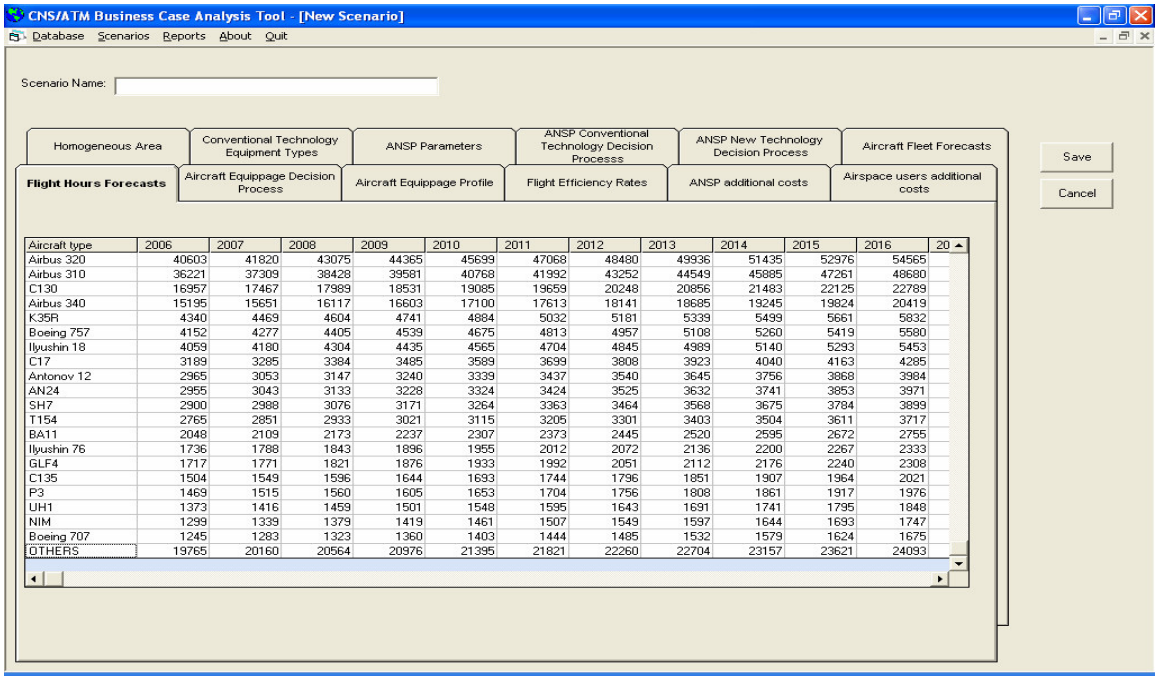
Scenario for Flight Hours Forecast

Click on the tab **Flight Hour Forecast.** The screen will appear with the aircraft types entered previously in **Aircraft Fleet Forecast,** displayed with zeros for flight hours for each of the years concerned, as shown below.



Aircraft type	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	20
Boeing 737 - 400	0	0	0	0	0	0	0	0	0	0	0	
DC-9-50	0	0	0	0	0	0	0	0	0	0	0	
Airbus 300-600	0	0	0	0	0	0	0	0	0	0	0	
Boeing 767-3/ER	0	0	0	0	0	0	0	0	0	0	0	
Boeing 777	0	0	0	0	0	0	0	0	0	0	0	
Boeing 727-2	0	0	0	0	0	0	0	0	0	0	0	
DC-10-4	0	0	0	0	0	0	0	0	0	0	0	
MD-11	0	0	0	0	0	0	0	0	0	0	0	
Boeing 747-400	0	0	0	0	0	0	0	0	0	0	0	
Air Transport Regior	0	0	0	0	0	0	0	0	0	0	0	
Airbus 330	0	0	0	0	0	0	0	0	0	0	0	
Airbus 320	0	0	0	0	0	0	0	0	0	0	0	
Airbus 310	0	0	0	0	0	0	0	0	0	0	0	
C130	0	0	0	0	0	0	0	0	0	0	0	
Airbus 340	0	0	0	0	0	0	0	0	0	0	0	
K35R	0	0	0	0	0	0	0	0	0	0	0	
Boeing 757	0	0	0	0	0	0	0	0	0	0	0	
Ilyushin 18	0	0	0	0	0	0	0	0	0	0	0	
C17	0	0	0	0	0	0	0	0	0	0	0	
Antonov 12	0	0	0	0	0	0	0	0	0	0	0	
AN24	0	0	0	0	0	0	0	0	0	0	0	
SH7	0	0	0	0	0	0	0	0	0	0	0	

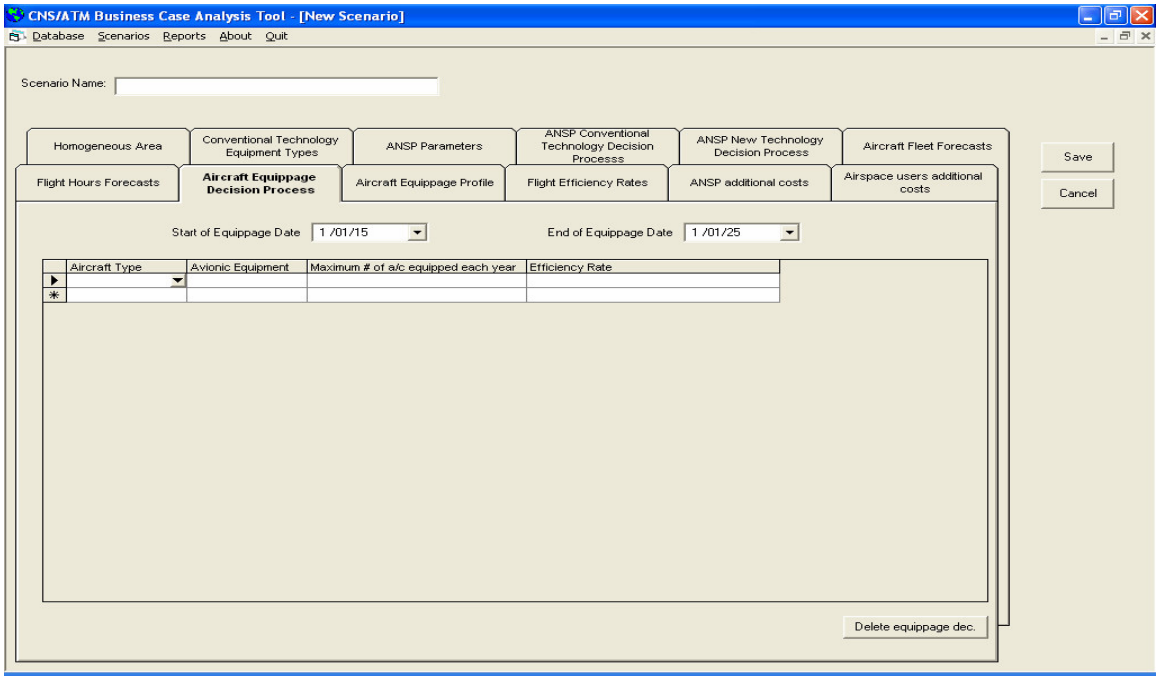
Replace the zeros with the forecast values of aircraft hours from 2006 to 2025 given in Table 8 of the appendix. The screen below shows the grid after the flight hours forecasts for all aircraft types have been entered.



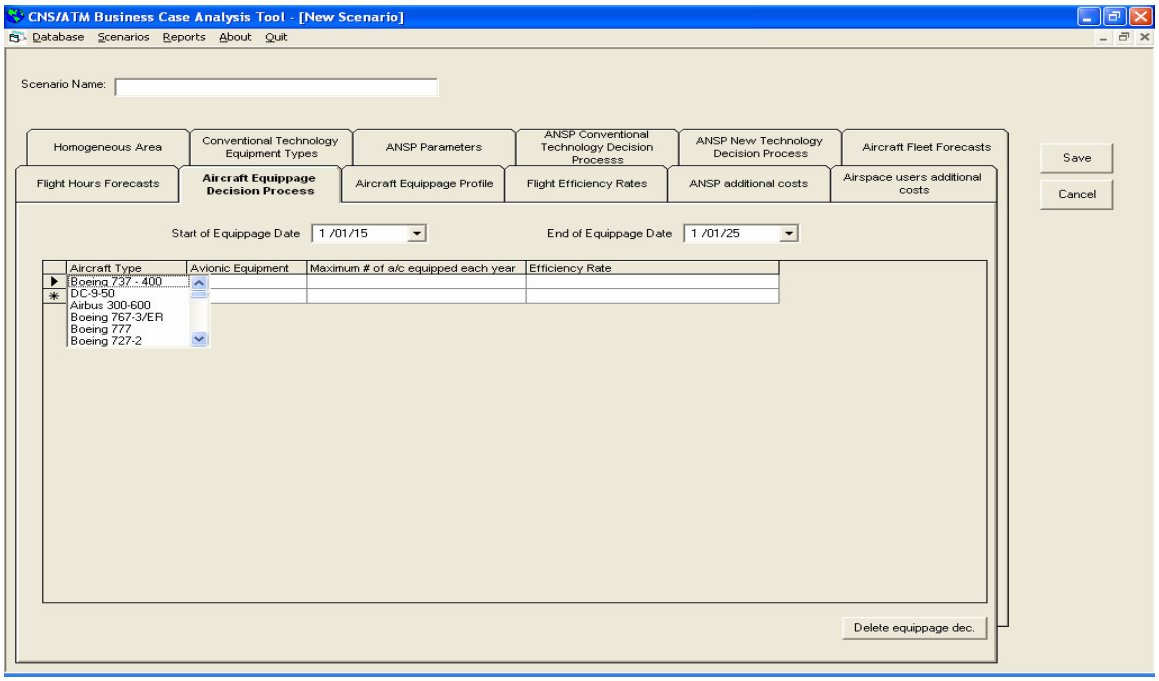
Aircraft type	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	20
Airbus 320	40603	41820	43075	44365	45699	47068	48480	49936	51435	52976	54565	
Airbus 310	36221	37309	38428	39581	40768	41992	43252	44549	45885	47261	48680	
C130	16957	17467	17989	18531	19085	19659	20248	20856	21483	22125	22789	
Airbus 340	15195	15651	16117	16603	17100	17613	18141	18685	19245	19824	20419	
K35R	4340	4469	4604	4741	4884	5032	5181	5339	5499	5661	5832	
Boeing 757	4152	4277	4405	4539	4675	4813	4957	5108	5260	5419	5580	
Ilyushin 18	4059	4180	4304	4435	4565	4704	4845	4989	5140	5293	5453	
C17	3189	3285	3384	3485	3589	3699	3808	3923	4040	4163	4285	
Antonov 12	2965	3053	3147	3240	3339	3437	3540	3645	3756	3868	3984	
AN24	2955	3043	3133	3228	3324	3424	3525	3632	3741	3853	3971	
SH7	2900	2988	3076	3171	3264	3363	3464	3568	3675	3784	3899	
T154	2765	2851	2933	3021	3115	3205	3301	3403	3504	3611	3717	
BA11	2048	2109	2173	2237	2307	2373	2445	2520	2595	2672	2755	
Ilyushin 76	1736	1788	1843	1896	1955	2012	2072	2136	2200	2267	2333	
GLF4	1717	1771	1821	1876	1933	1992	2051	2112	2176	2240	2308	
C135	1504	1549	1596	1644	1693	1744	1796	1851	1907	1964	2021	
P3	1469	1515	1560	1605	1653	1704	1756	1808	1861	1917	1976	
UH1	1373	1416	1459	1501	1548	1595	1643	1691	1741	1795	1848	
NIM	1299	1339	1379	1419	1461	1507	1549	1597	1644	1693	1747	
Boeing 707	1245	1283	1323	1360	1403	1444	1485	1532	1579	1624	1675	
OTHERS	19765	20160	20564	20976	21395	21821	22260	22704	23157	23621	24093	

Scenario for Aircraft Equipage Decision Process

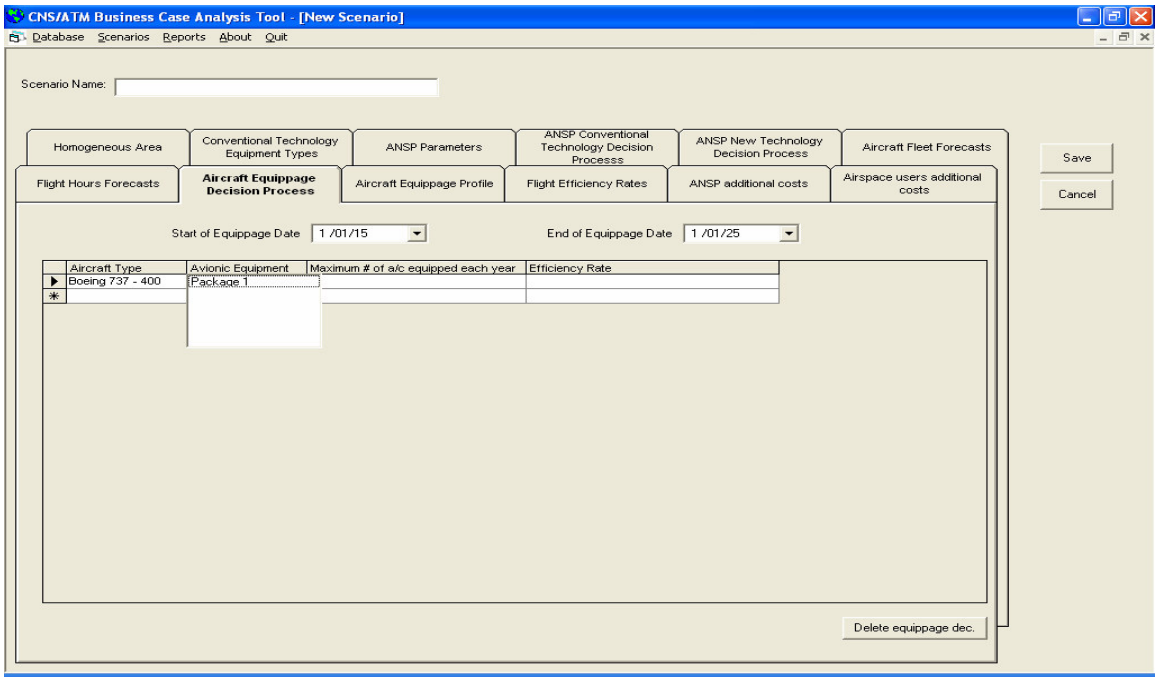
Click on tab **Aircraft Equipage Decision Process.**



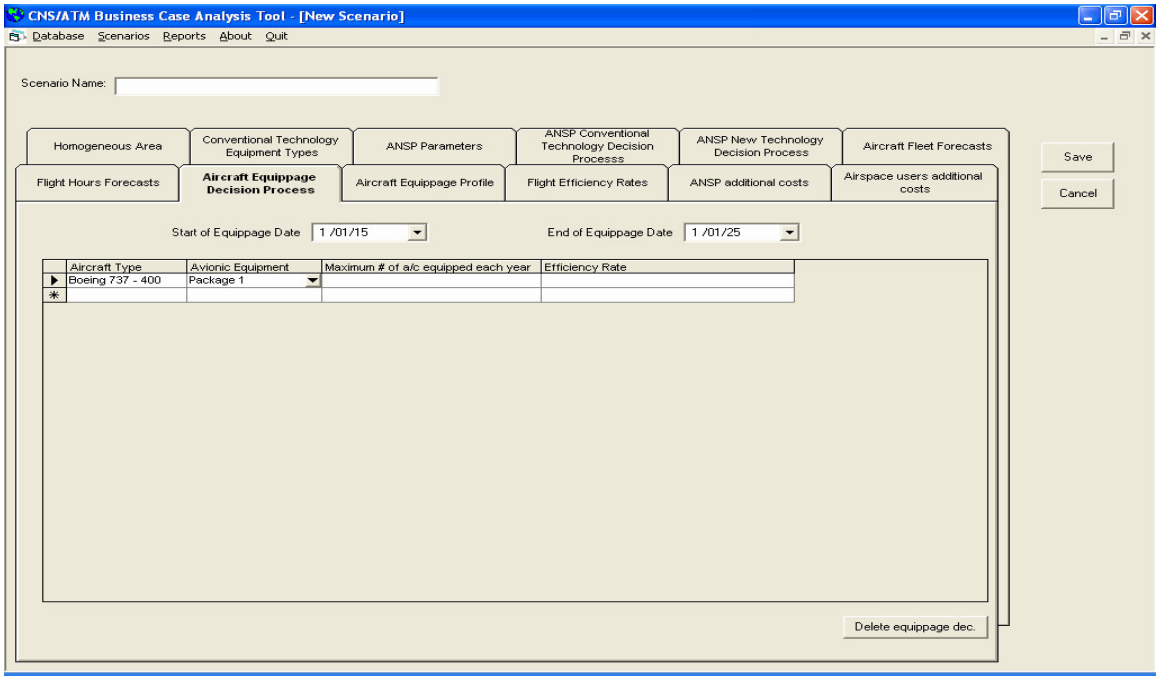
Refer to Table 9 of the appendix, which provides the aircraft equipage decisions. In this illustrative case, the equipage of the fleet of each aircraft type with the set of avionics Package 1, starts in the year 2015 and ends in the year 2025. As can be seen in the screen, the default starting and ending equipage dates are 1/01/15 and 1/01/25 respectively. The user has the flexibility of modifying these dates as necessary. To enter the data in the first row, select **Boeing 737-400** from the **Aircraft Type** pull down list and click on it.



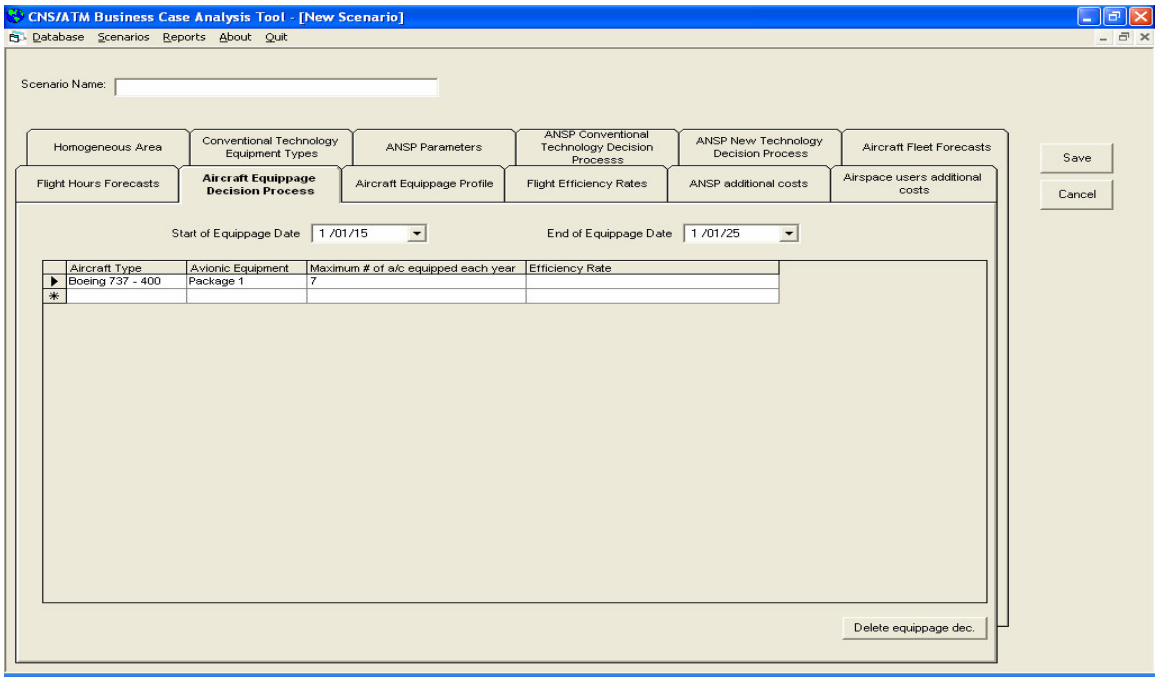
In the same row, move on to the next column i.e. **Avionic Equipment** and click in the cell.



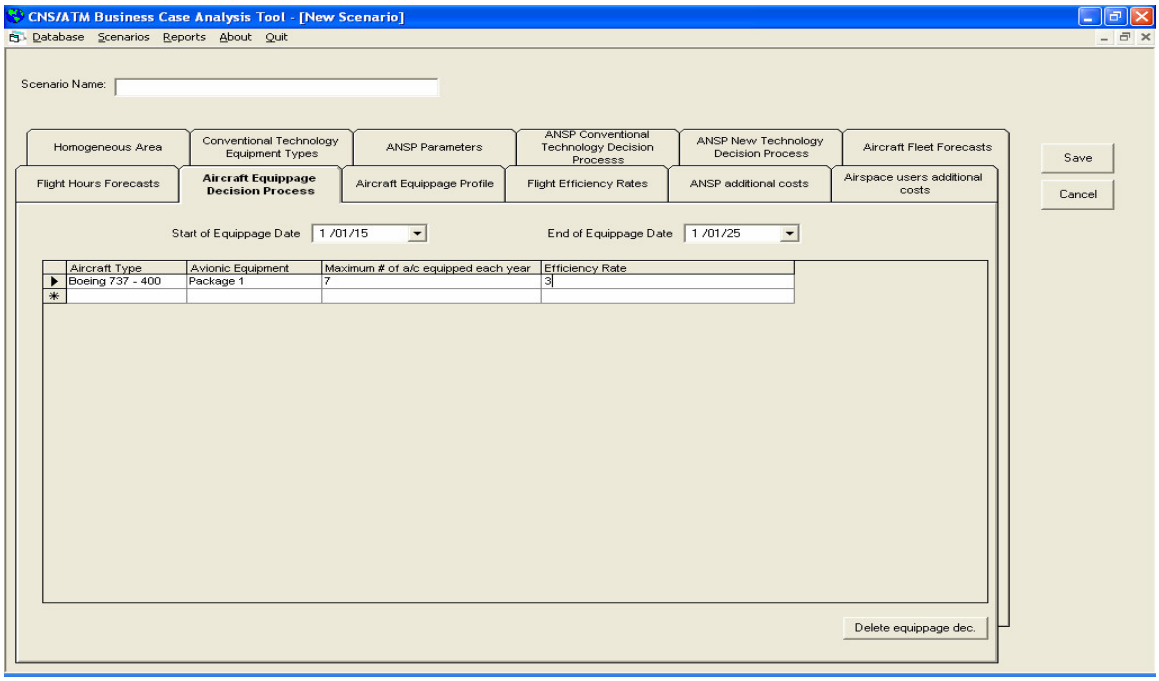
In the same row, select **Package 1** from the pull down list in the column **Avionic Equipment** and click on it**.**



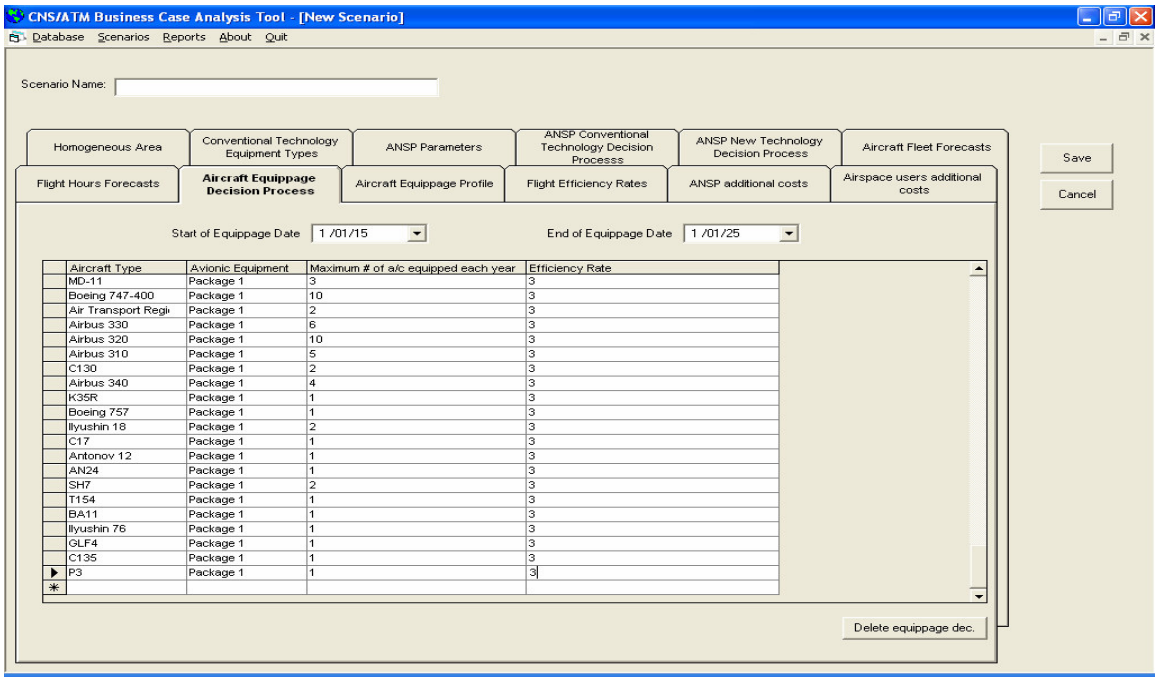
In the same row, move on to the next column **Maximum # of a/c equipped each year**. Click in the cell and type 7 (refer to Table 7 of the appendix).



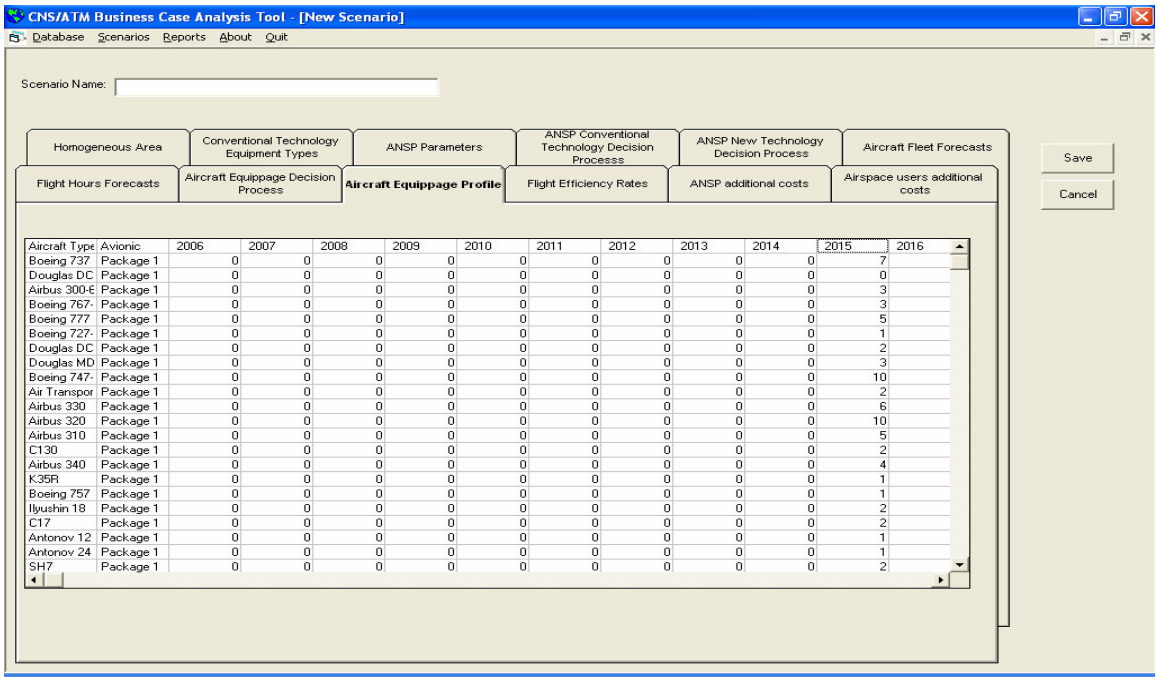
In the same first row, move on to column **Efficiency Rate** and type 3 (refer to Table 9 of the appendix).



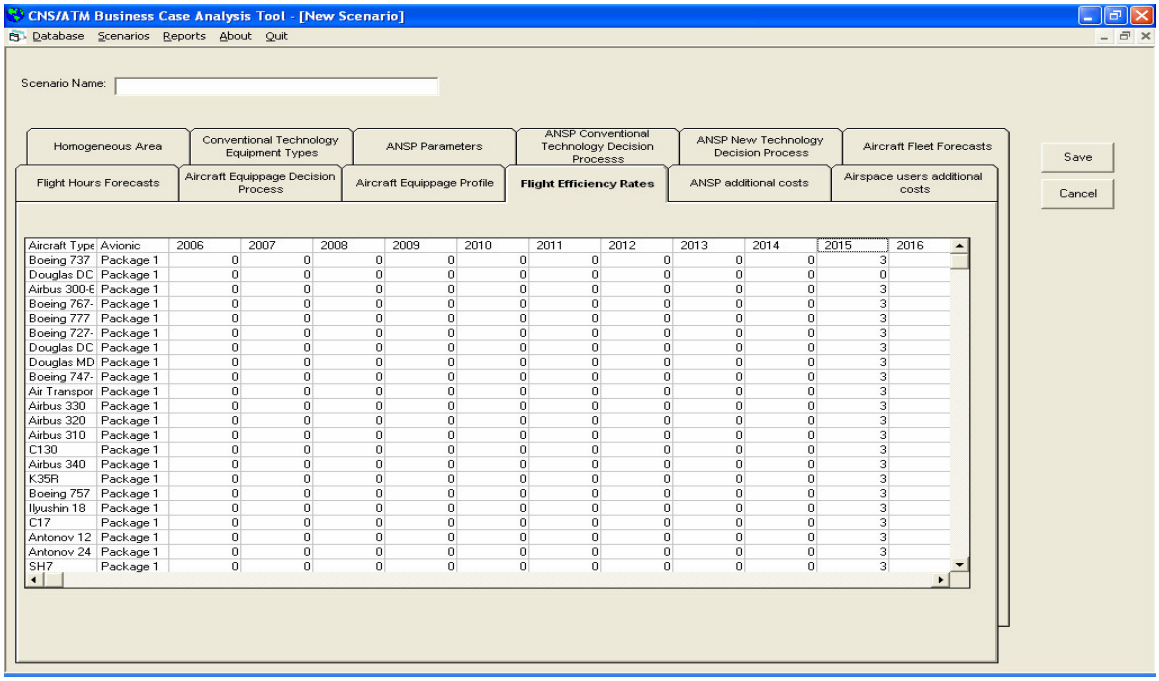
Repeat the same procedure to enter the data for all aircraft types to be equipped with new avionics as shown.



Click on the Scenario Tab **Aircraft Equipage Profile.** The grid on this Tab has already been created by the software based on the equipage decision process previously made. The user can make any changes to the number of aircraft equipped each year as necessary.

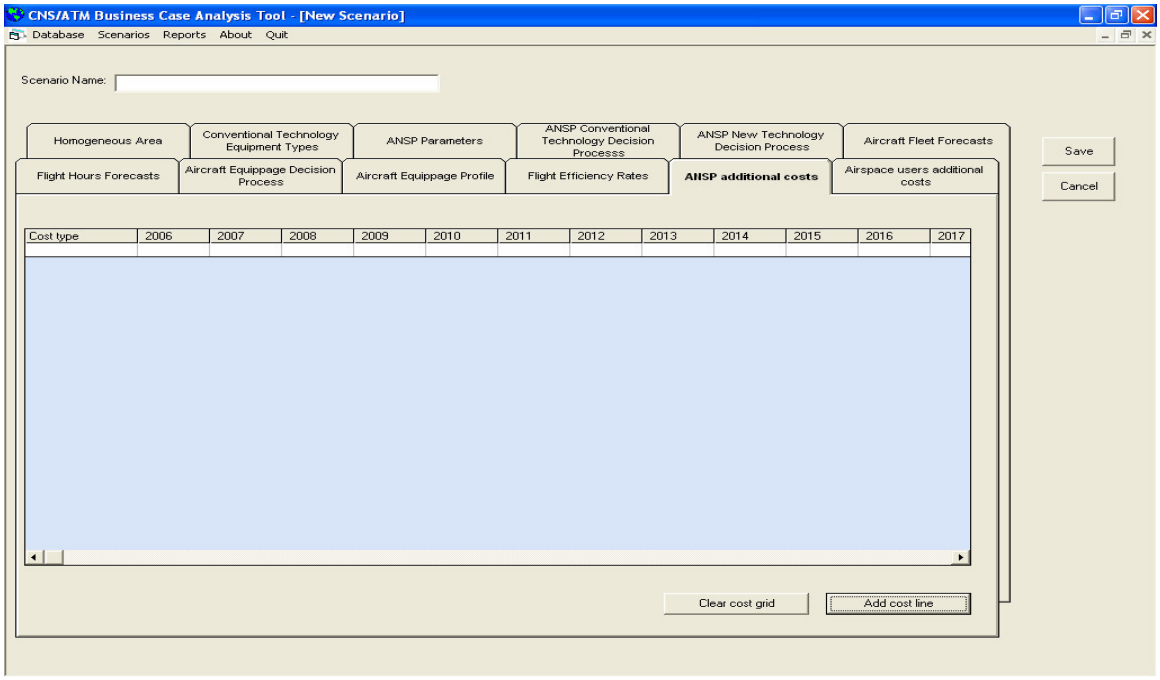


Click on the Scenario Tab **Fight Efficiency Rates.** The grid on this Tab has already been created by the software, as for the equipage profile tab, based on the equipage decision process. The user can make any changes on the yearly flight efficiency rates as required.

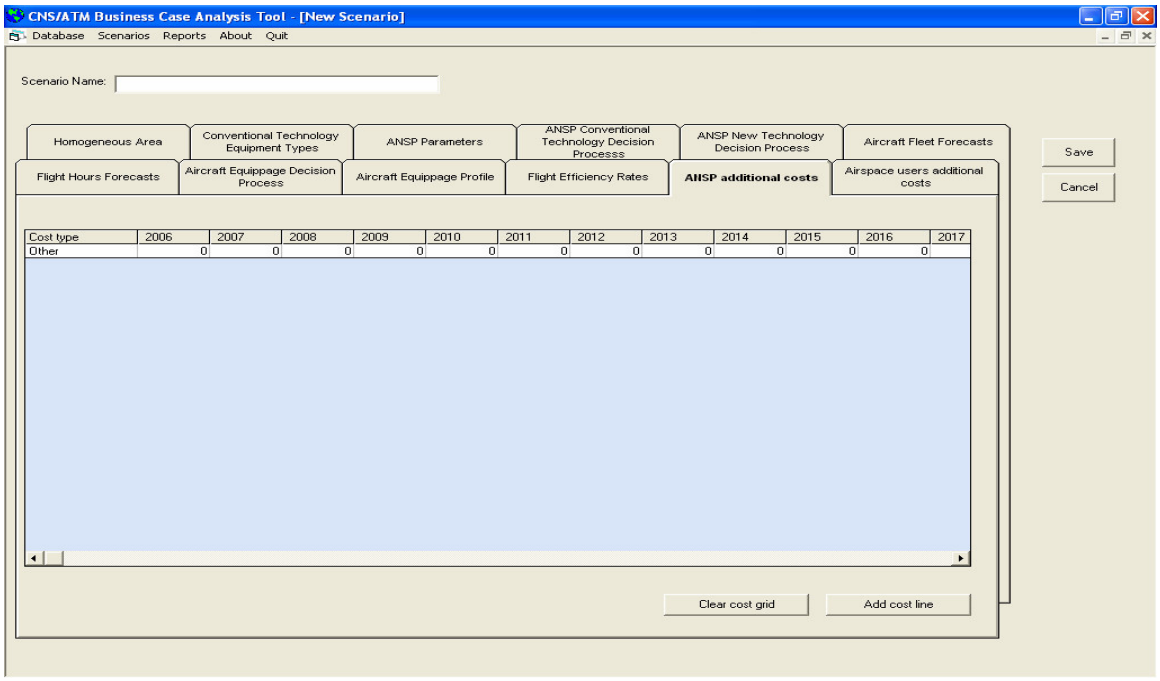


Scenario for ANSP additional costs

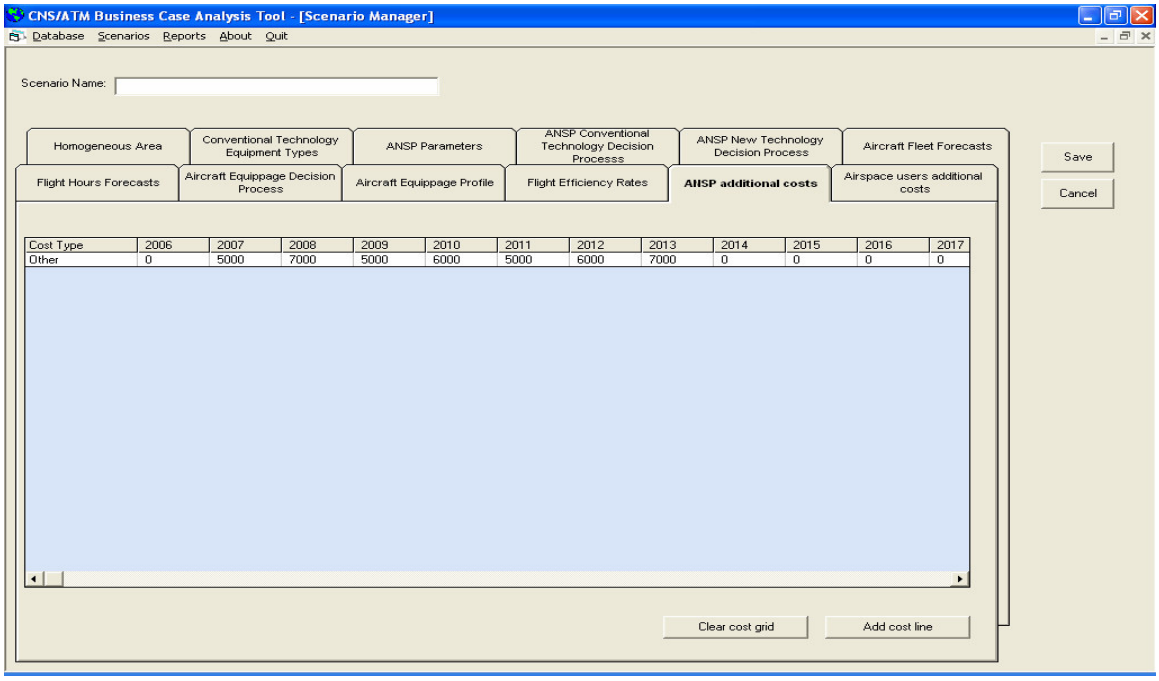
Click on the **ANSP additional costs** Tab. Click on the command button **Build cost grid** on the lower right corner.



Click in the first cell (row 1, coloumn 1) of the grid. Select "**Other"** from the pull down list.

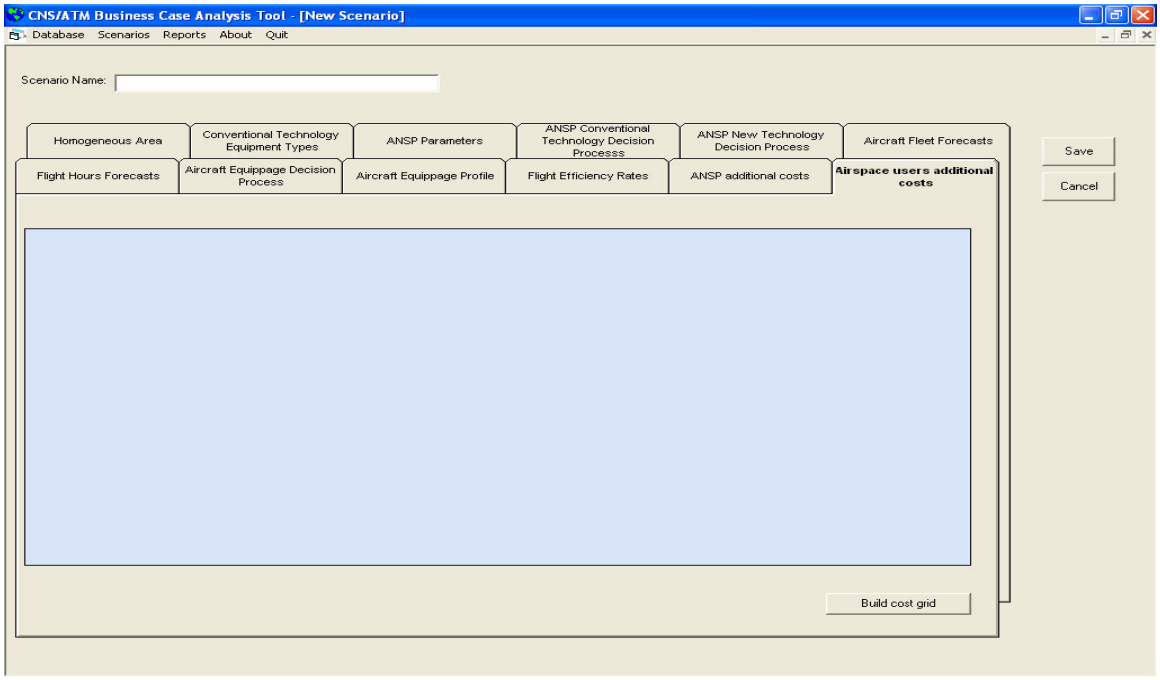


Enter the additional cost data as given in table 10 of the appendix.

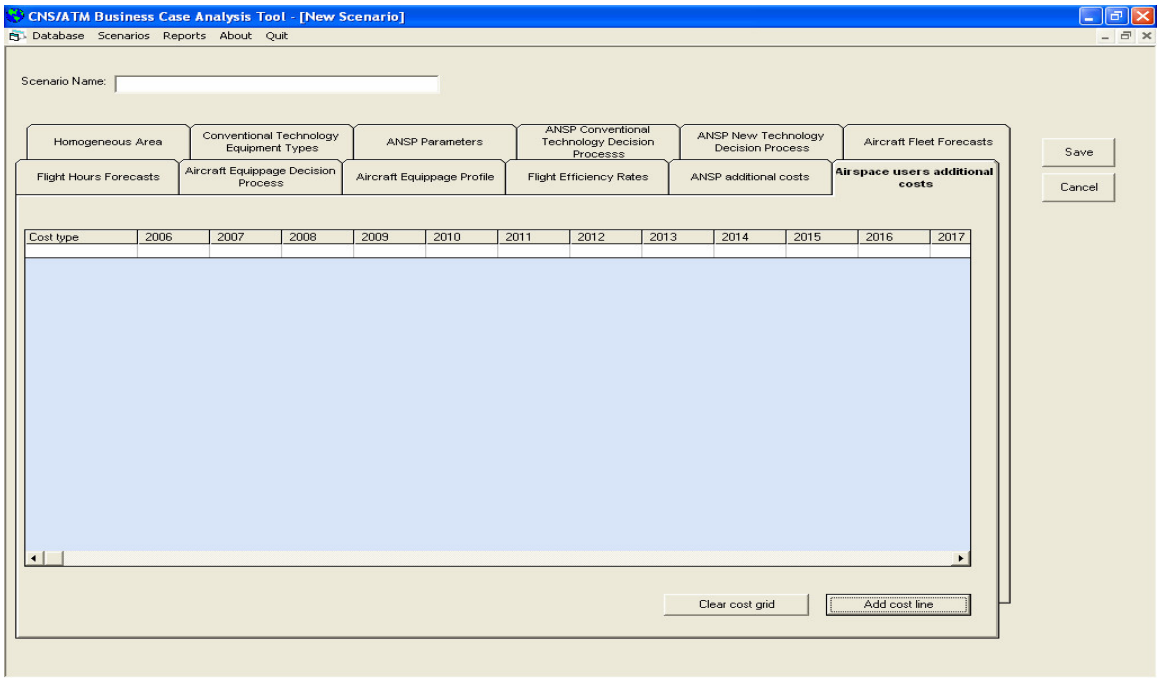


Scenario for Airspace users additional costs

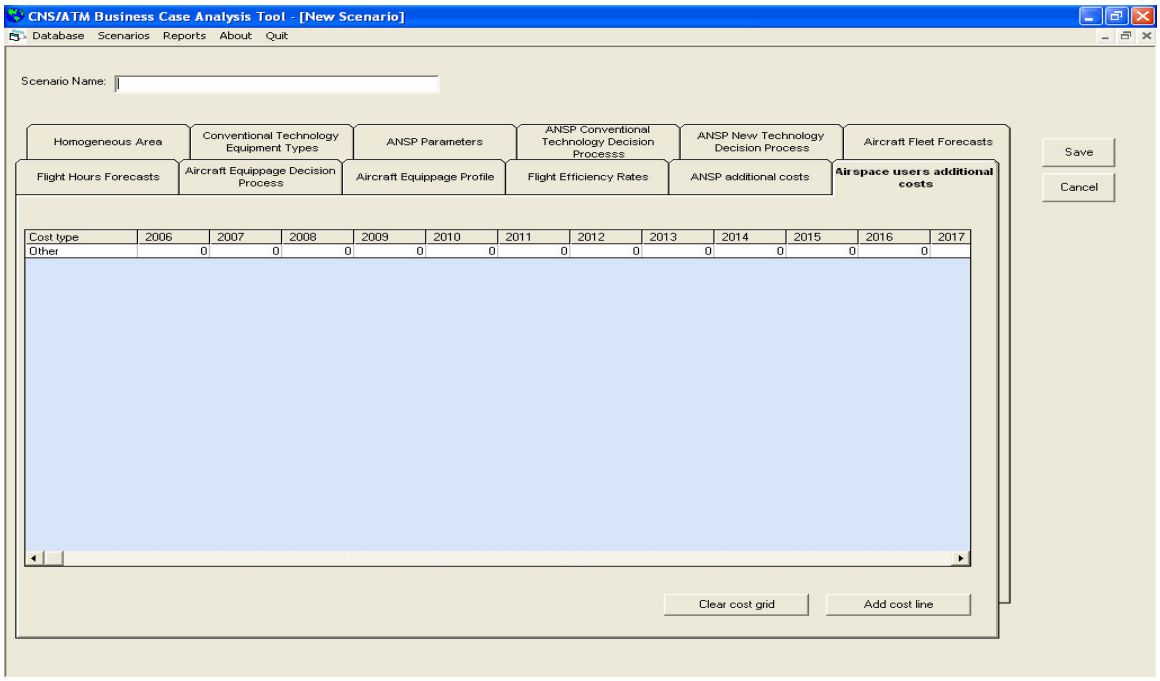
Click on the **Airspace users additional costs** Tab.



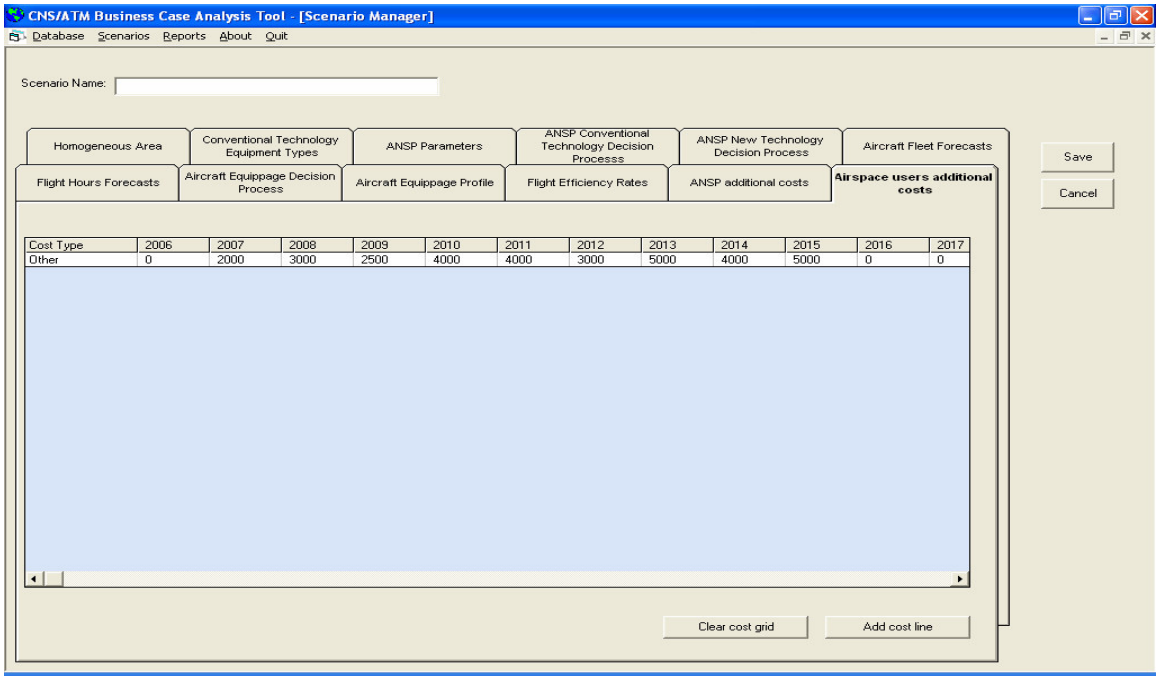
Click on the command button **Build cost grid** on lower right corner of the screen.



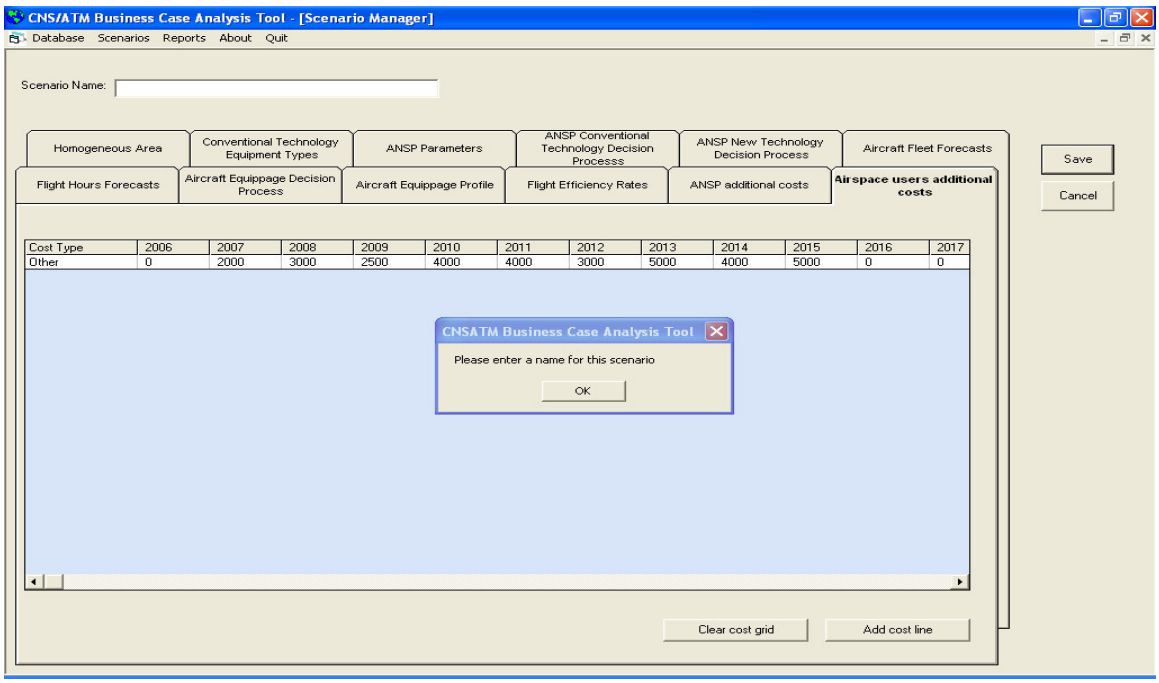
Click in the cell (row 1, column 1). Select "**Other"** from the pull down list.



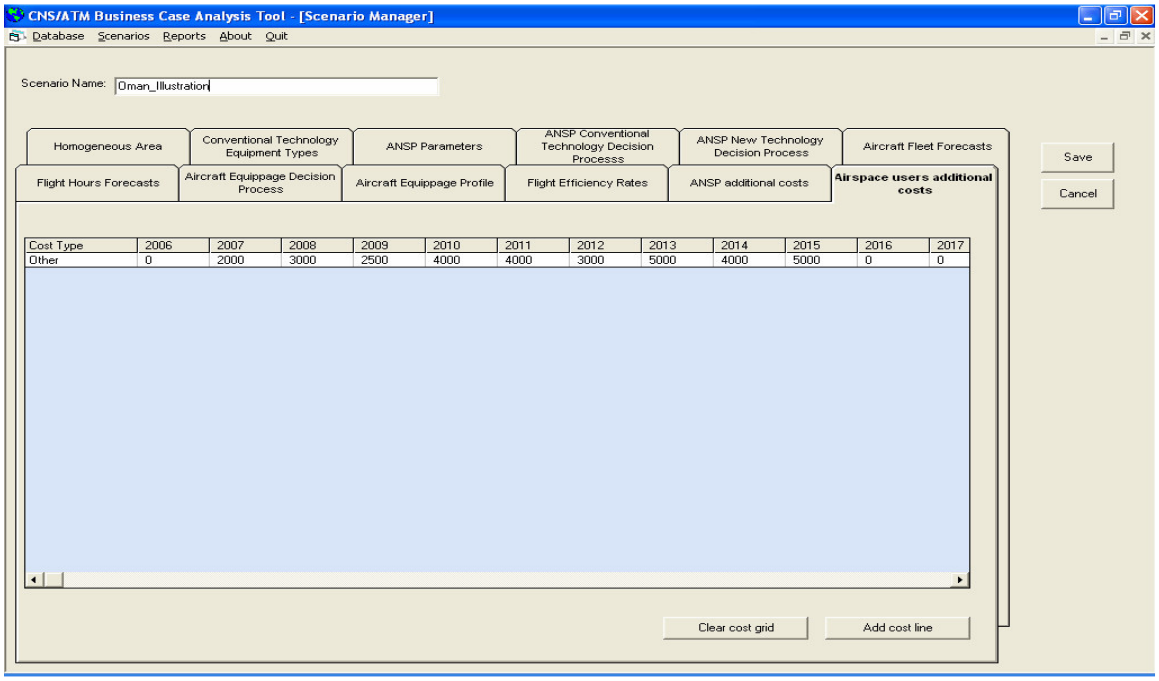
Enter the additional cost data as provided in table 11.



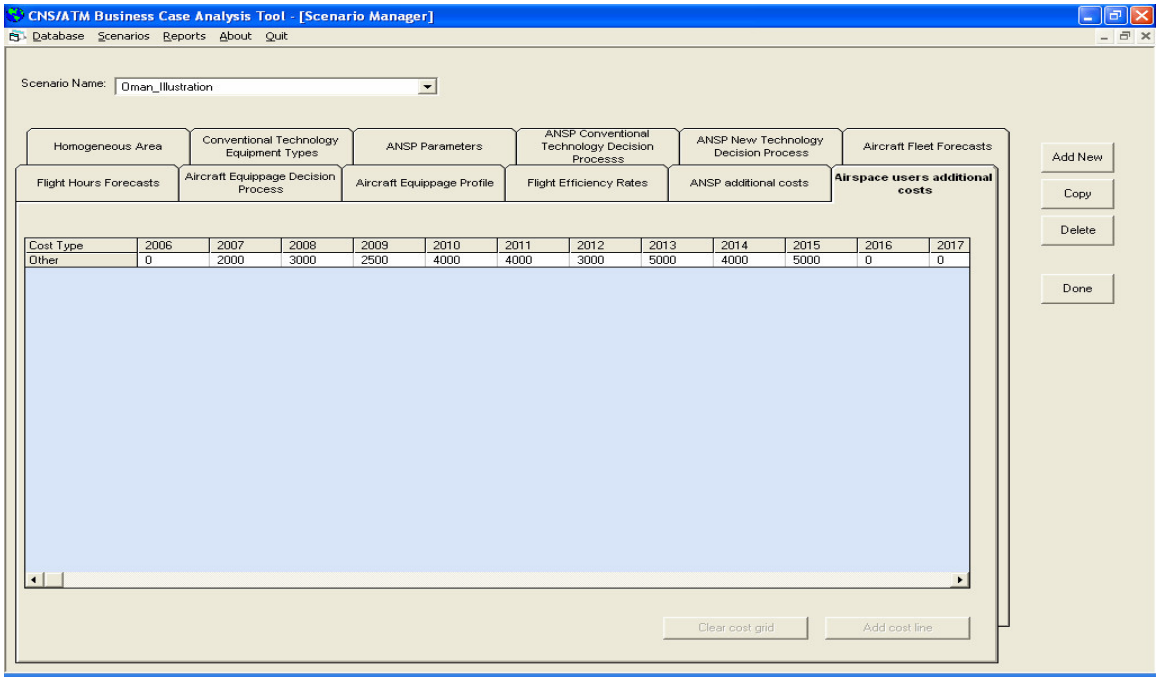
This brings the scenario creation to a completion and it can be saved by clicking on the "**Save"** command button on the top right side.



Click on the "OK" button. Enter a name for the scenario, say, Illustrative example.



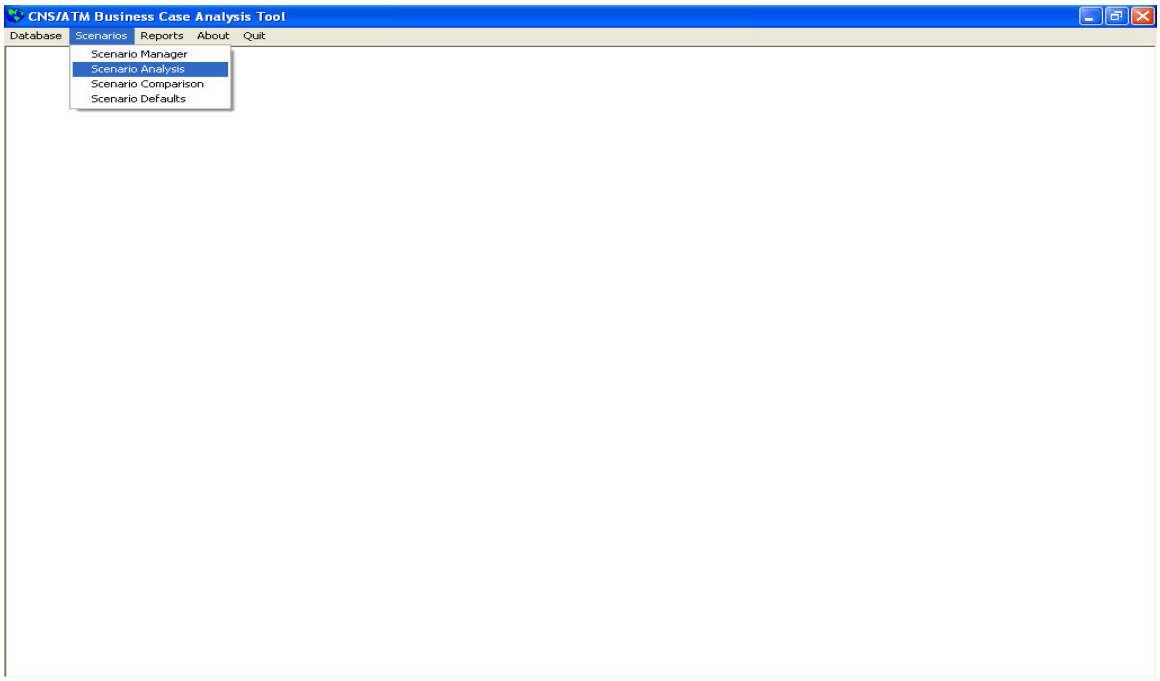
Click on the "**Save"** command button to save the scenario or on the "**Cancel**" command button to discard it .



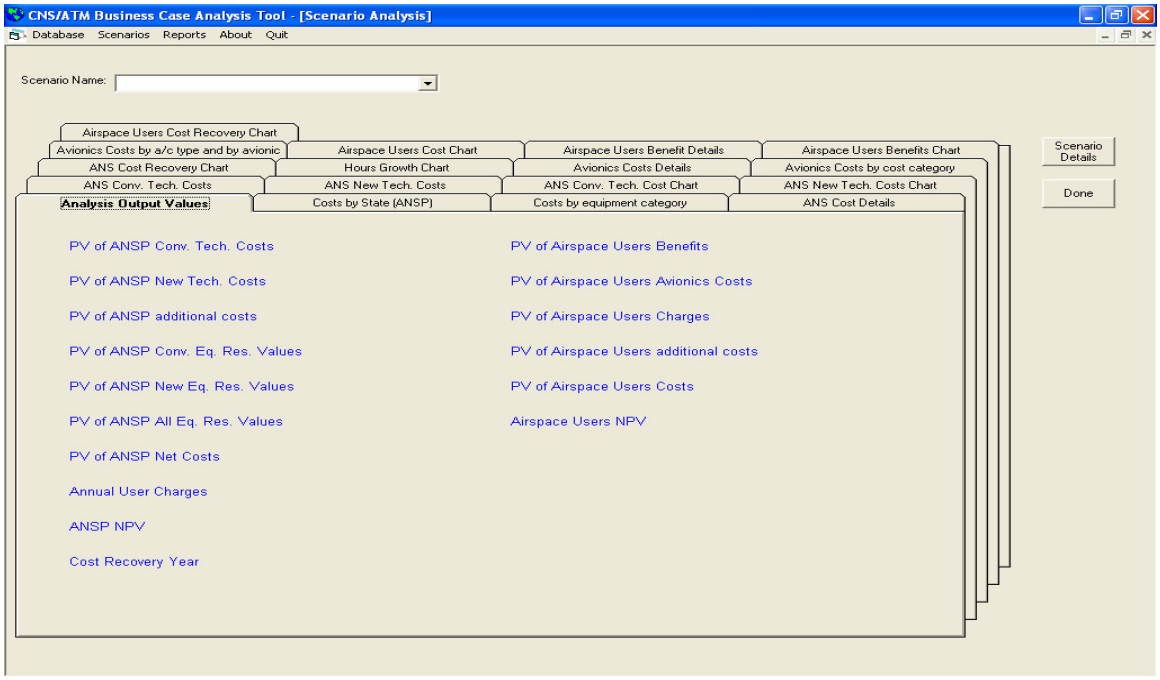
It should be noted that the user has the option of creating a new scenario and/or copying an existing one. After copying a scenario, the user has to make the necessary changes to the data inputs and then save the copy as a separate scenario under a new name.

SCENARIO ANALYSIS

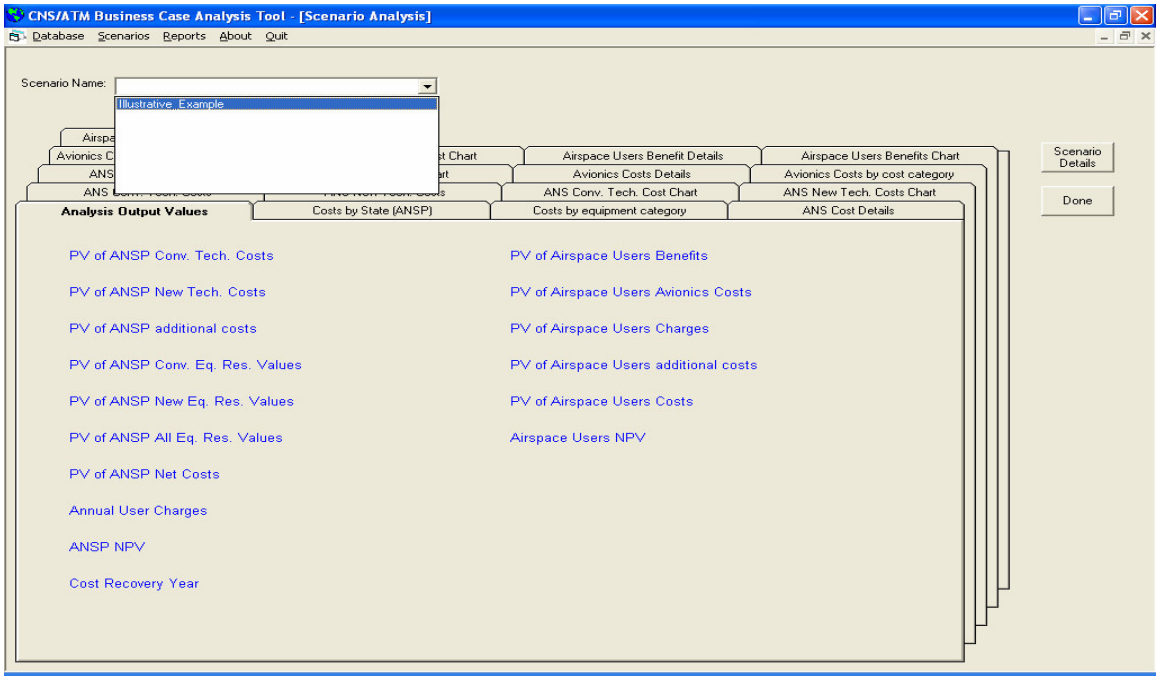
Based on the **Illustrative_Example** scenario**,** the cost and benefit results can be seen by selecting the menu item **Scenario Analysis**.



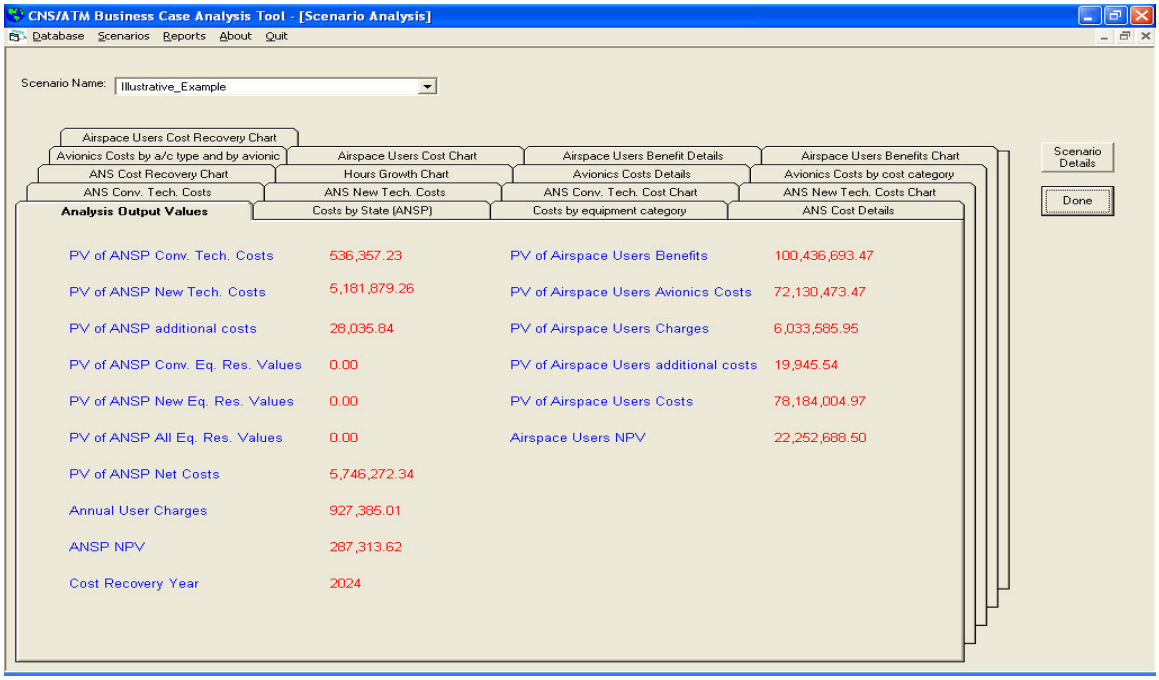
The following screen will appear**.**



Select **Illustrative_Example** from the pull-down list on top left of the screen.

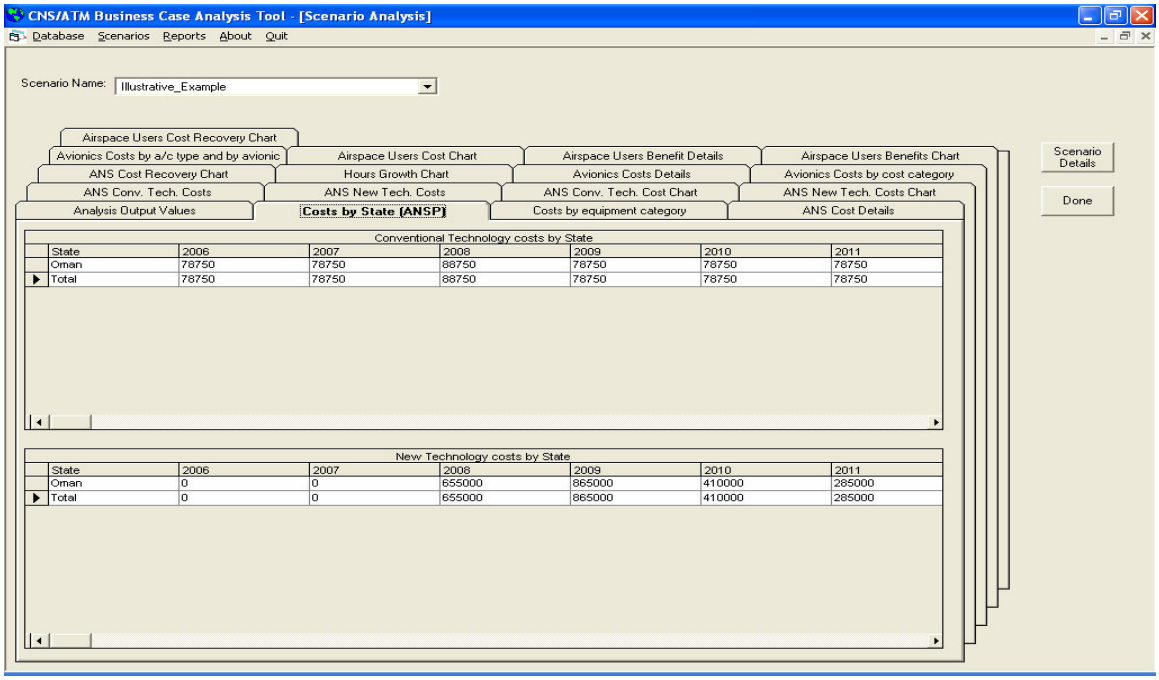


The analytical results for the scenario are given under 17 tabs. The first tab **Analysis Output Values** is shown on the opening screen.



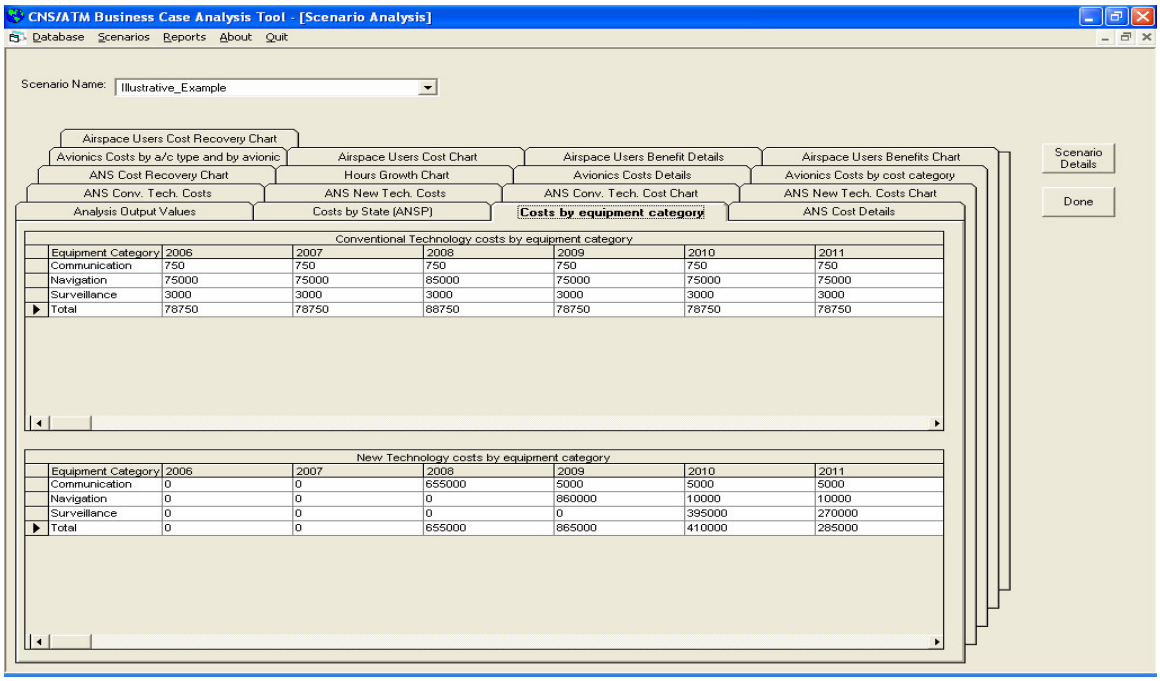
This tab displays all the summary results for both the ANSP and the airspace users.

Click on the tab **Costs by State (ANSP).**



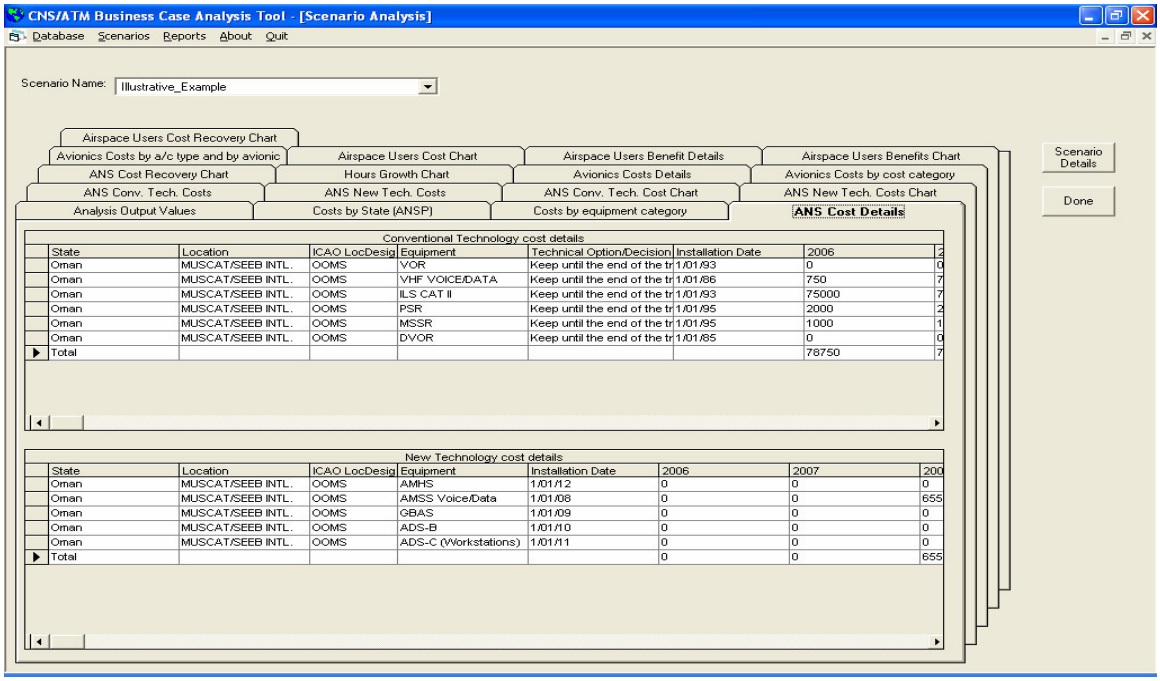
This tab shows the distribution of conventional and new technology costs by State. In this particular case, only Oman is included in the analysis. If the scenario covers more than one State, the yearly costs for each State will be shown separately.

Click on the tab **Costs by equipment category.**



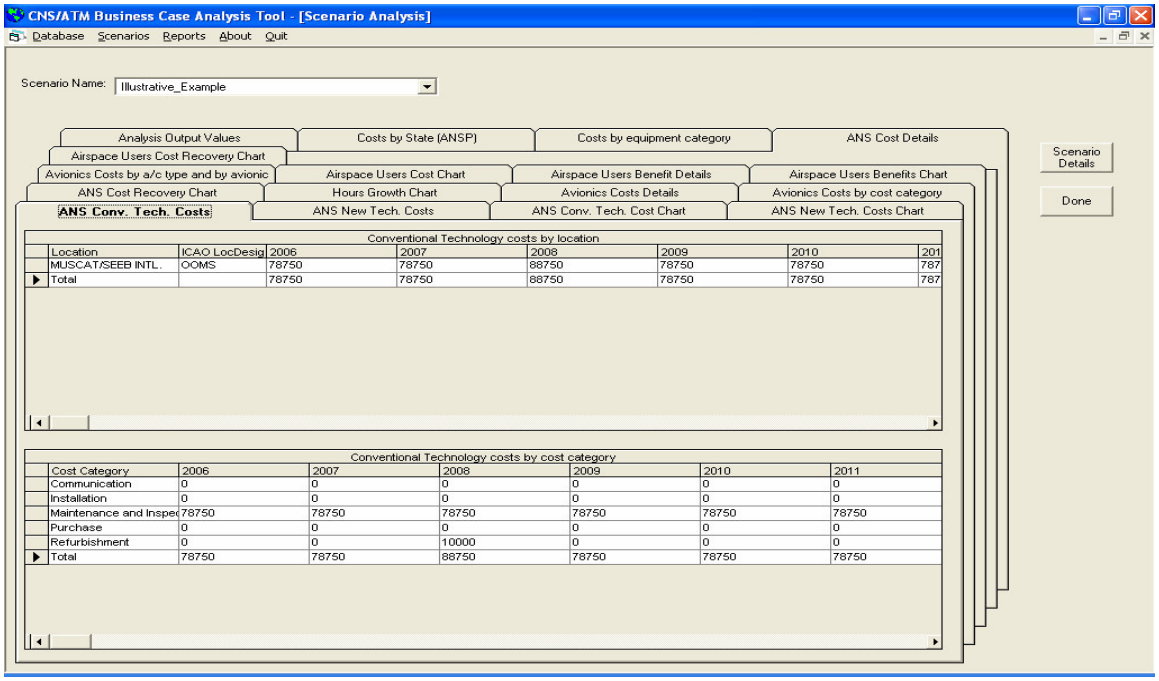
This tab shows the distribution of conventional and new technology costs by equipment category (Communication, Navigation, Surveillance, ATM, etc.) as defined by the user.

Click on tab **ANS Cost Details**.



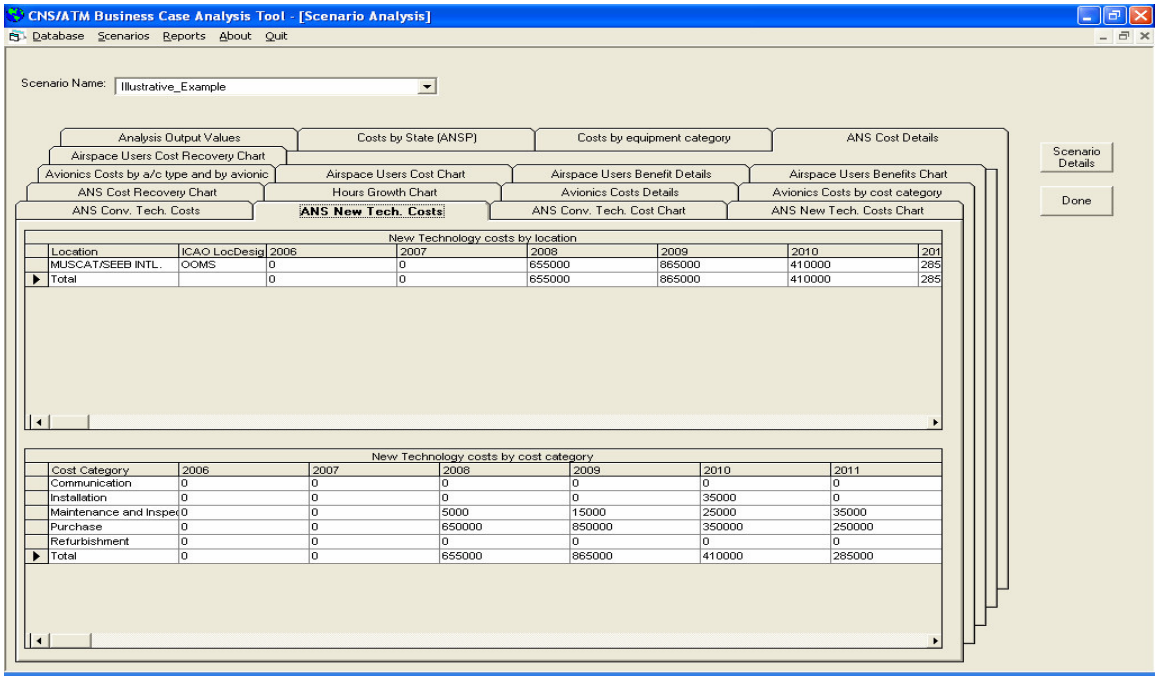
This tab shows the details of the ANSP conventional and new technology annual costs. Results are given by equipment item and listed by State and location.

Click on **ANS Conv. Tech. Costs**.



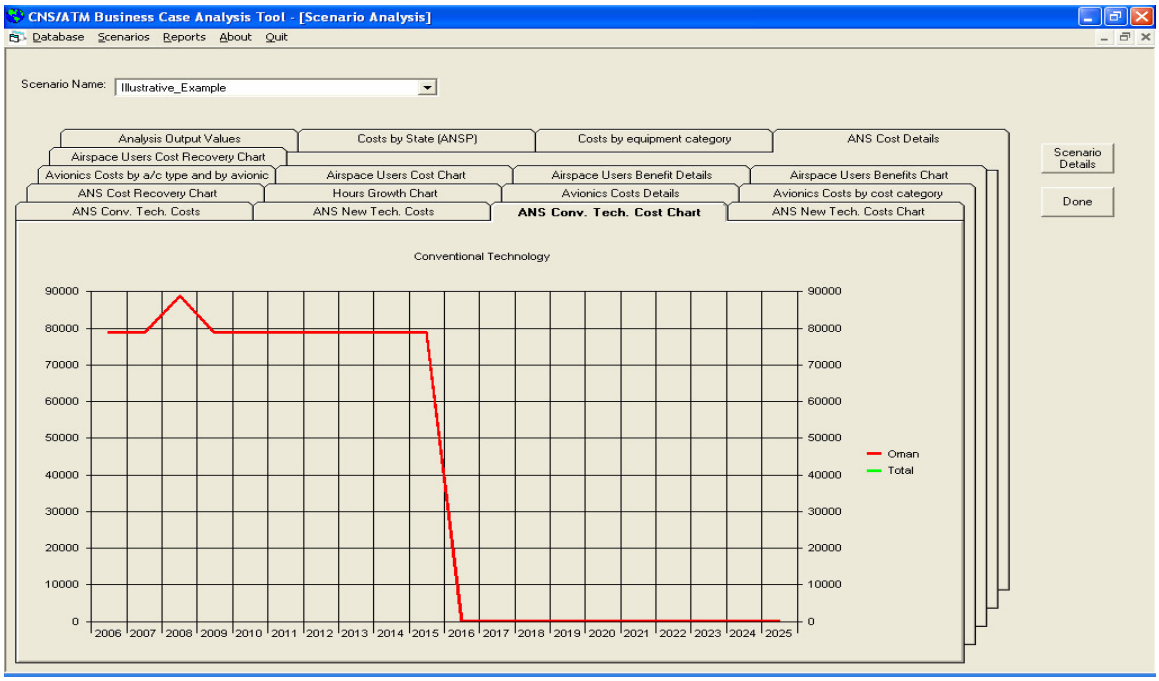
This tab shows the details of the ANSP conventional technology annual costs. Results are given by location in the upper table and by cost category in the lower table.

Click on tab **ANS New Tech. Costs**.



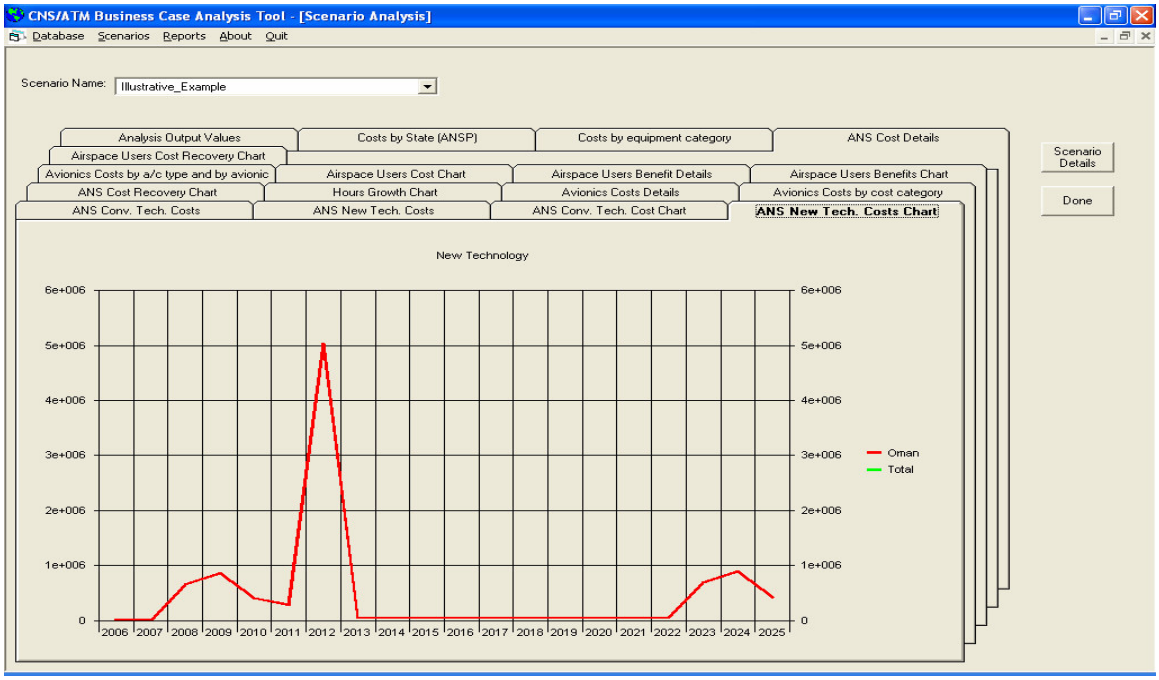
This tab shows the details of the ANSP new technology annual costs. Results are given by location in the upper table and by cost category in the lower table.

Click on tab **ANS Conv. Tech. Cost Chart**.



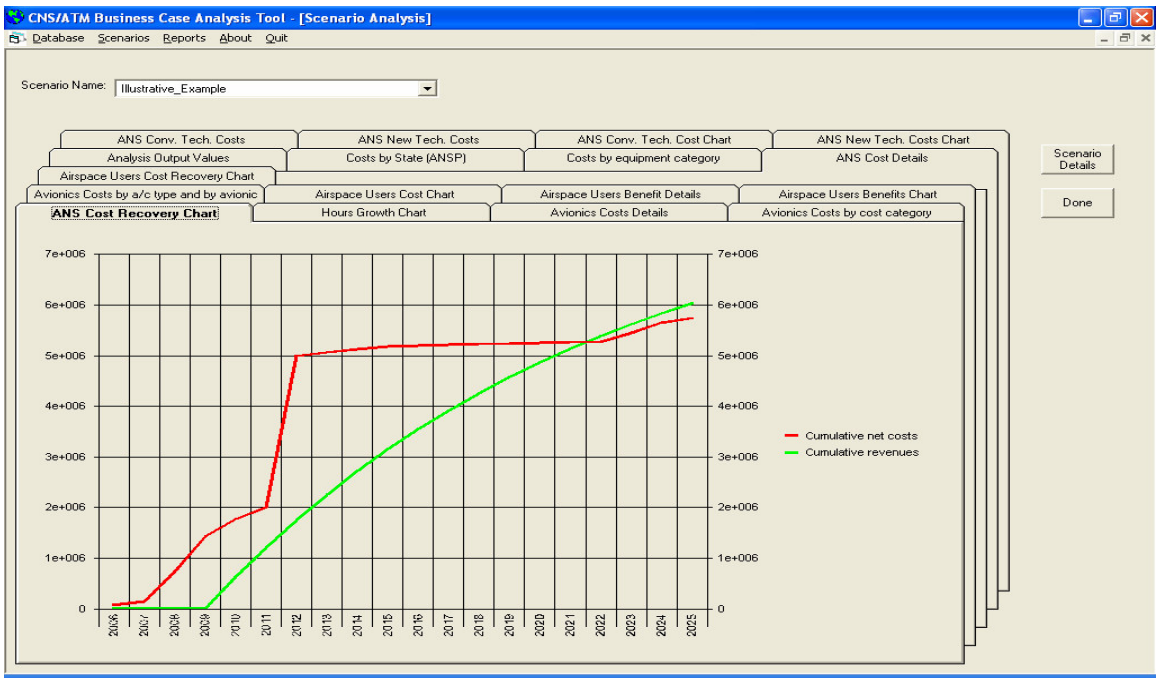
The chart above displays the evolution of the conventional technology cost. The increase in cost in the year 2008 is due to the refurbishment of some of the equipment (a VOR and an ILS) which were installed in 1993. At the end of the transition period in the year 2015, the cost of maintaining the conventional technology equipment is reduced to zero.

Click on tab **ANS New Tech. Costs Chart**.



The chart above displays the new technology cost by State and total. You may notice that a peak occurred in 2012. This corresponds to the installation of the AMHS system.

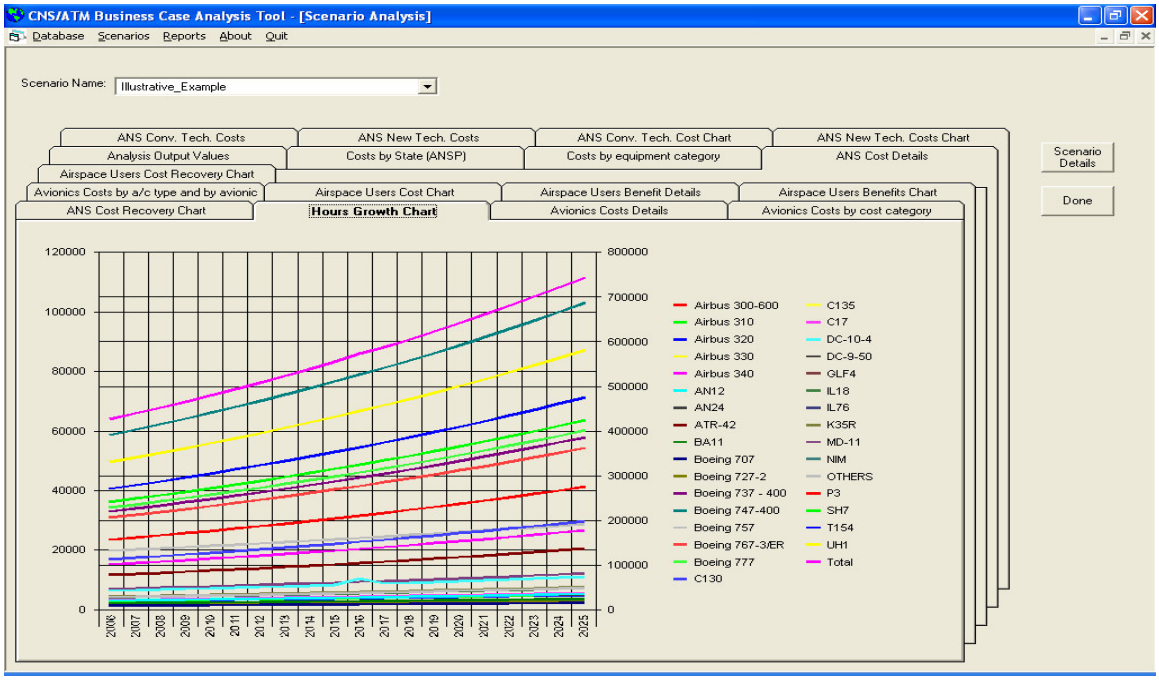
Click on tab **ANS Cost Recovery Chart**.



The previous chart shows the cumulative net costs (costs minus residual values) and the cumulative revenues (from user charges). The cumulative revenues curve crosses the cumulative costs curve in 2022: the breakeven year. The full cost recovery takes place in

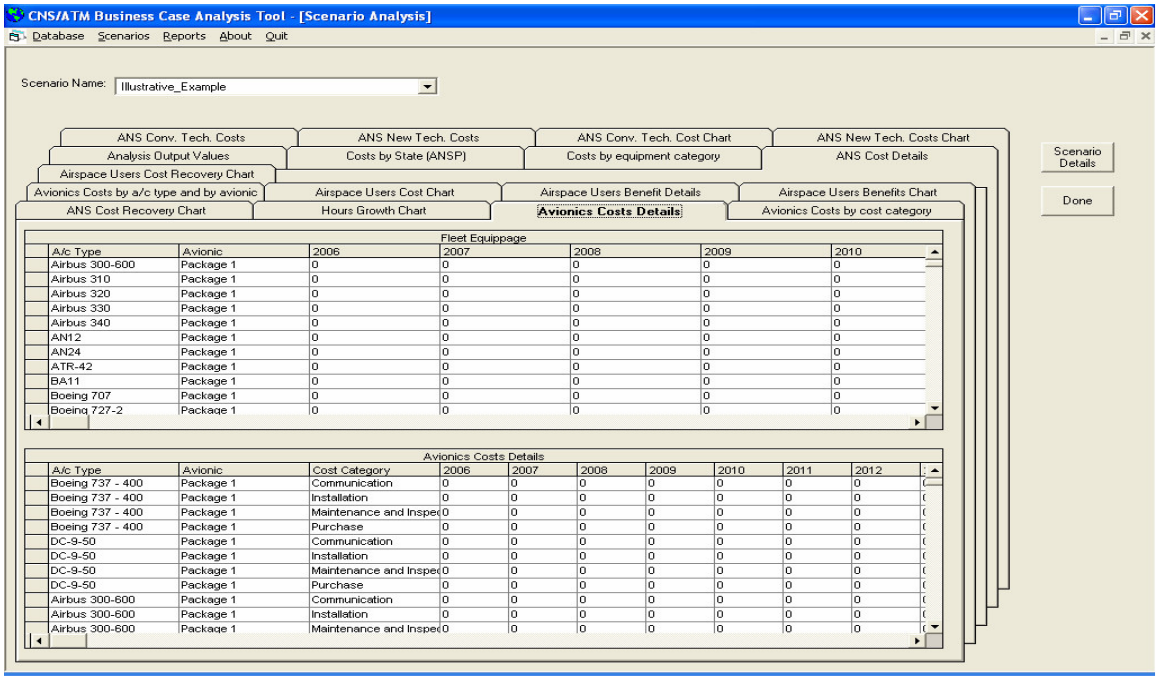
2024. At the end of the analysis period, cumulative revenues exceed cumulative net costs by 5%, which can be explained by the assumption of a 5% profit margin.

Click on tab **Hours Growth Chart**.



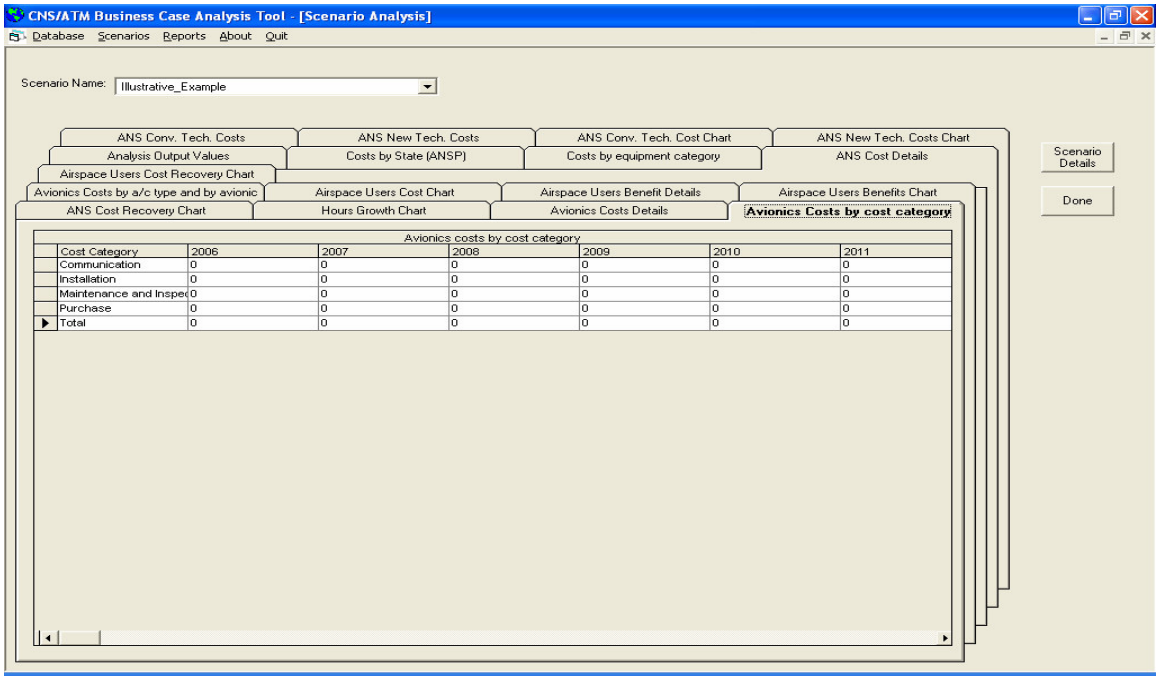
This chart displays the flights hours forecasts by aircraft type (left vertical axis) as well as the total (right vertical axis).

Click on tab **Avionics Costs Details**.



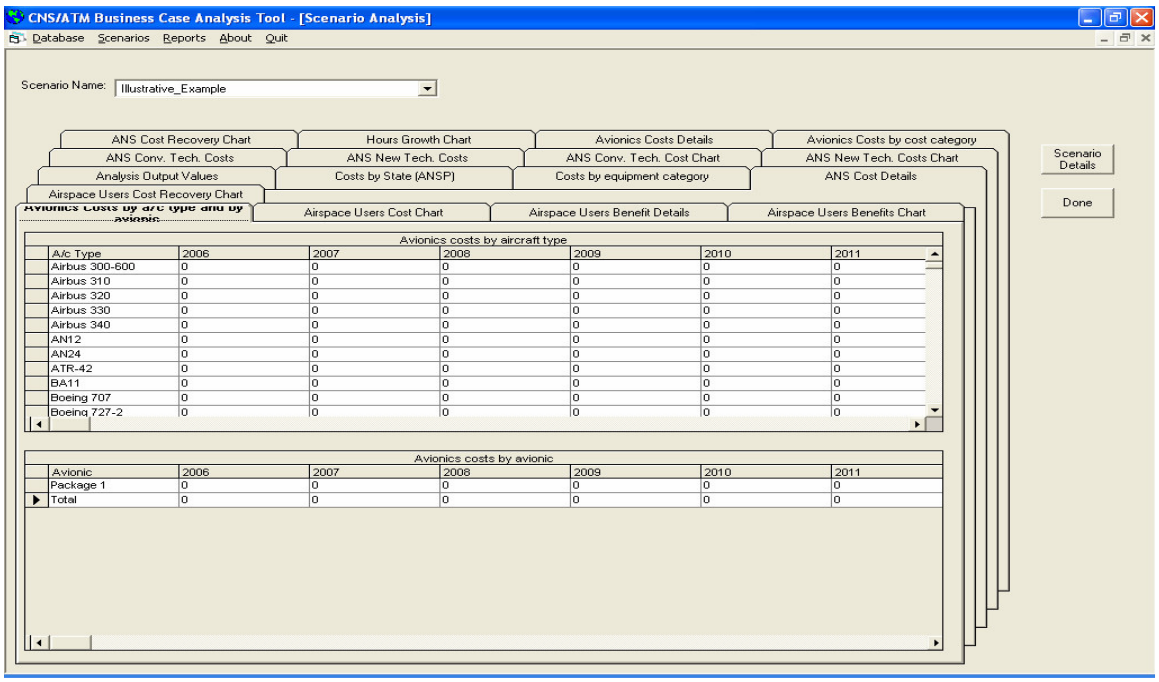
This on the previous screen shows by aircraft type and by new technology avionic (or package of avionics) the number of aircraft equipped each year on the top of the screen and the corresponding annual costs by cost category on the bottom of the screen.

Click on tab **Avionics Costs by cost category.**



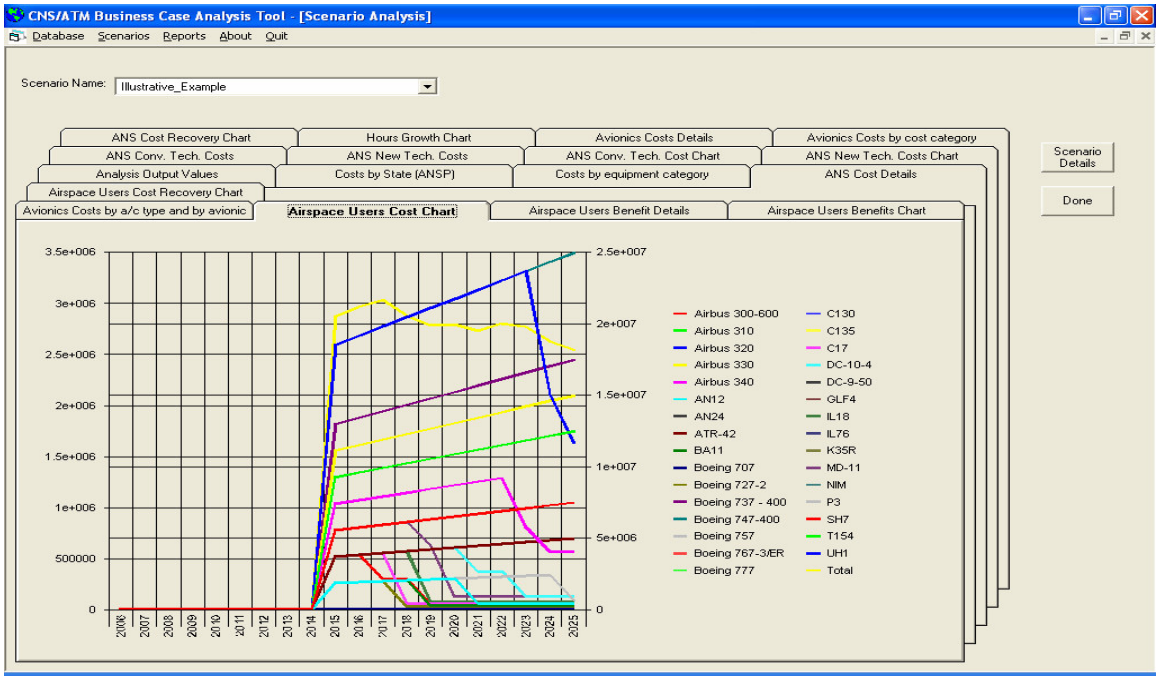
This tab shows the annual new technology avionics costs by cost category.

Click on tab **Avionics Costs by a/c type and by avionic**.



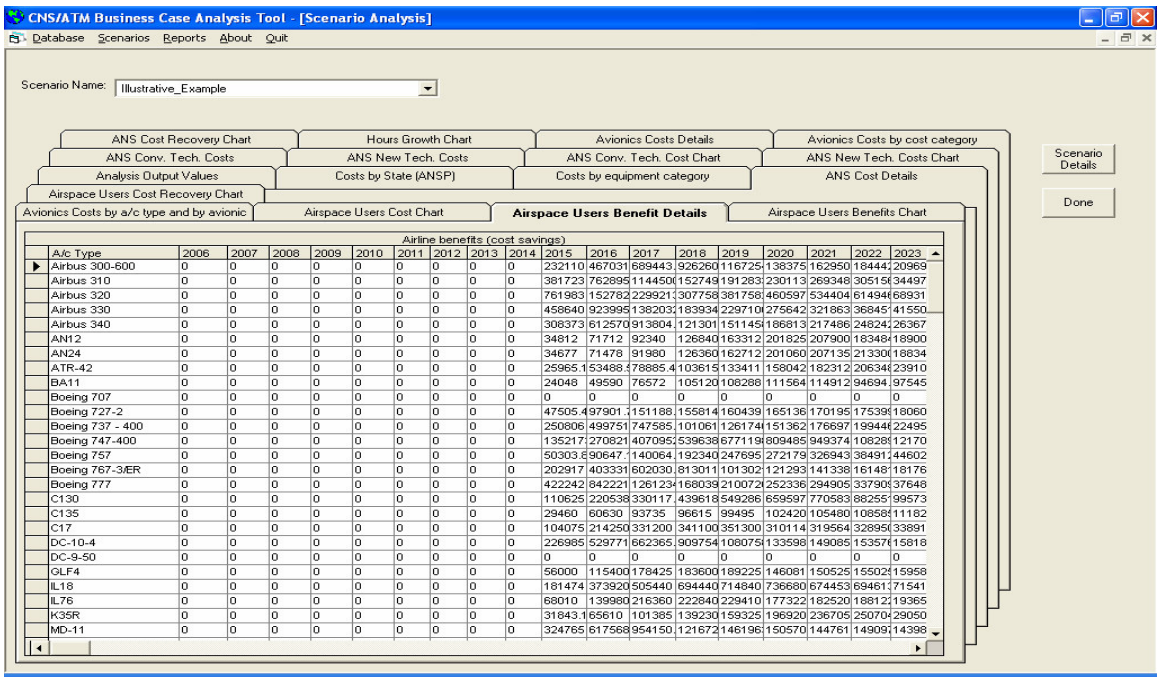
The tab on the previous screen shows the annual avionics costs by aircraft type.

Click on the tab **Airspace Users Cost Chart**.



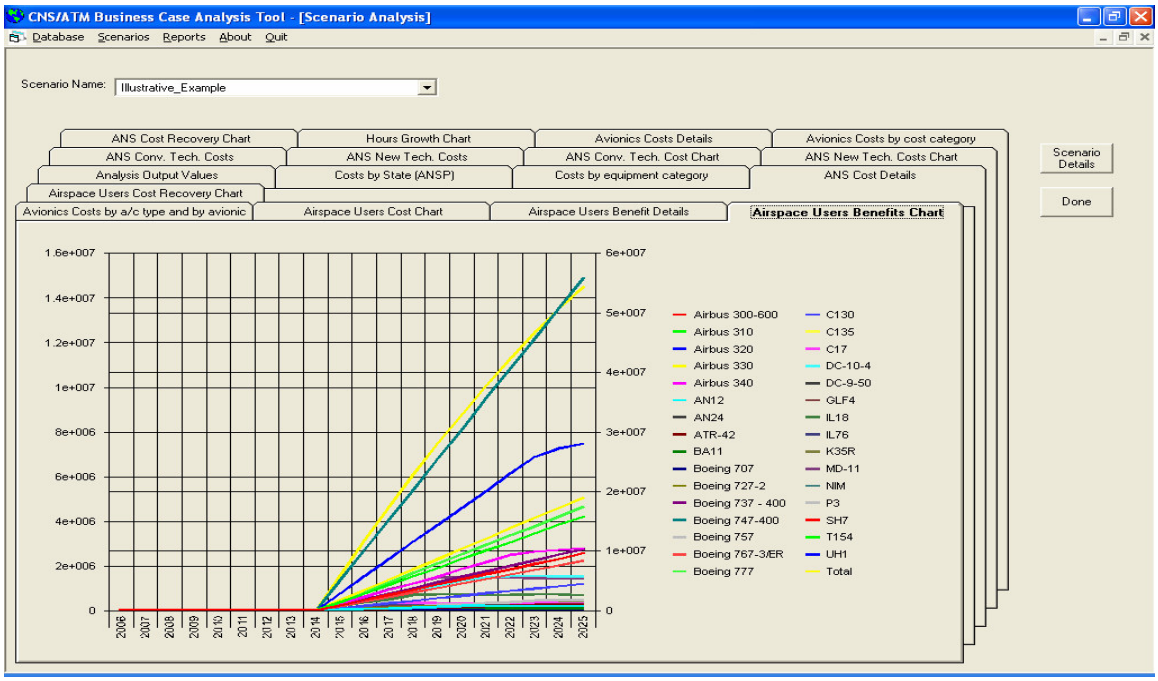
This chart displays the airspace users avionics costs by aircraft type as well as the total. The chart has two axes. Values for the individual aircraft types should be read on the left axis while values for the total should be read on the right axis.

Click on the tab **Airspace Users Benefit Details**.



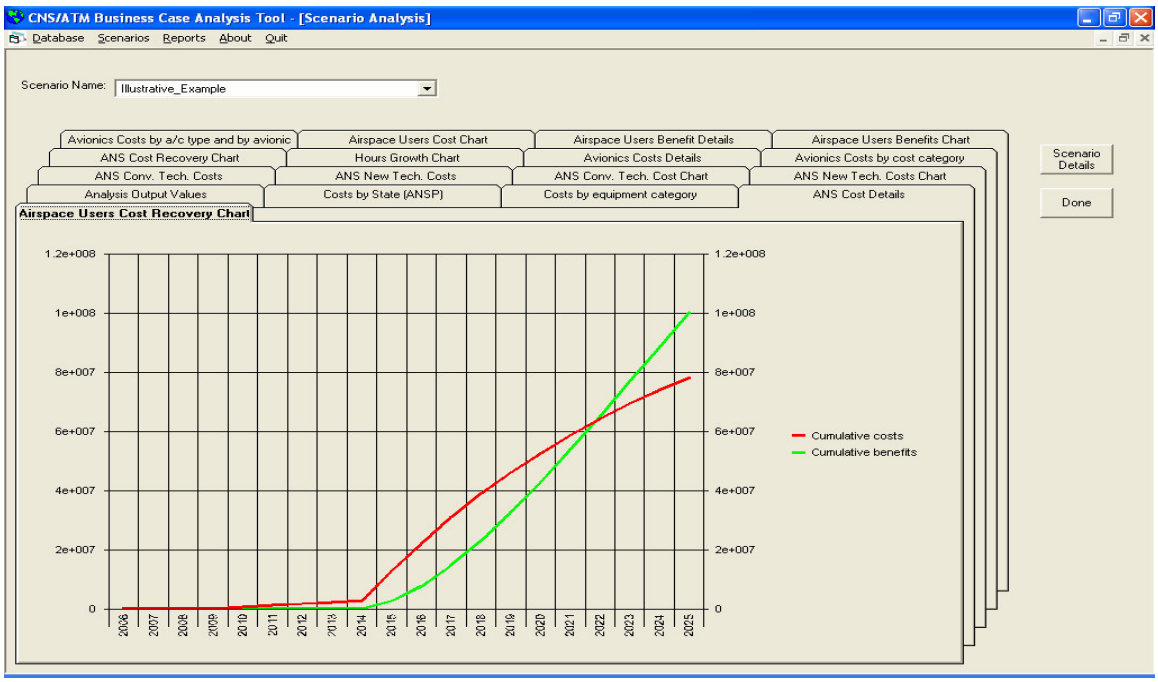
The tab on the previous screen displays the airspace users benefits by aircraft type and by year.

Click on **Airspace Users Benefits Chart**.



This chart shows the airspace users benefits from the reduction in flight time. The data is displayed by aircraft type and the total. The chart has two axes. Values for the individual aircraft types should be read on the left axis while values for the total should be read on the right axis.

Click on the tab **Airspace Users Cost Recovery Chart**.



This chart shows the cost recovery for the airspace users. The cumulative costs for airspace users include the cost of aircraft equipage in addition to the user charges. The cumulative benefits stem from the flight efficiency gained. In this case, cumulative revenues for the users will exceed the cumulative benefits starting from 2022.

APPENDIX

DATA FOR THE CASE STUDY

The following tables summarize the data needed for this case study (*please note that this data is for illustration purposes only).* All costs are expressed in 2006 US dollars.

Equipment and avionics data

Table 1: Conventional Technology Equipment Costs

Equipment Type	Life Cycle (years)	Equipment Category	Purchase Cost	Installation Cost	Maintenance & Inspection Cost	Communication Cost	Refurbishment Cost	Decommissioning Cost
VOR	15	Nav	150000	0	0	0	5000	0
VHF VOICE/DATA	15	Com	620000	0	750	0	2000	0
PSR	15	Sur	10000000	0	2000	0	50000	0
MSSR	15	Sur	5400000	0	1000	0	0	0
ILS Cat II	15	Nav	650000	0	75000	0	5000	0
DVOR	15	Nav	380000	0	0	0	4000	0

Table 2: New Technology Equipment Costs

Equipment Type	Life Cycle (years)	Equipment Category	Purchase Cost	Installation Cost	Maintenance & Inspection Cost	Communication Cost	Refurbishment Cost	Decommissioning Cost
AMHS	15	Communication	5000000	0	5000	0	0	0
AMSS Voice/Data	15	Communication	650000	0	5000	0	0	0
GBAS	15	Navigation	850000	0	10000	0	0	0
ADS-B	15	Surveillance	350000	35000	10000	0	0	0
ADS-C (Workstations)	15	Surveillance	250000	0	10000	0	0	0

Table 3 : Conventional Technology Equipment Installation Dates

Equipment Type	Installation Date
VOR	1/1/1993
VHF VOICE/DATA	1/1/1986
ILS CATII	1/1/1993
PSR	1/1/1995
MSSR	1/1/1995
DVOR	1/1/1985

Table 4: Avionics Costs

Avionic type	Acquisition Cost	Installation Cost	Maintenance Cost	Communication Cost
MMR with ILS (with connection to LAAS-GNSS)	76500	4000	2500	0
SATCOM	90000	10000	2500	0
VDL TDMA (voice/data)	27000	3000	2000	0
Dedicated ADS computer with ADS	36000	4000	2000	0
Package 1	229500	21000	9000	0

Package 1 is the package consisting of all the avionics listed above and thus its cost is the sum of all the avionics costs.

Scenario related data

Table 5: ANSP Parameters

Start Date of Analysis	1/1/2006
End Date of Analysis	1/1/2025
CNS/ATM Operational Date	1/1/2010
Transition Period	5 years
Stretching period	5 years after the end of life cycle
Refurbishment period	7 years after the end of life cycle
Default life cycle	15 years
Year switching month	6 (corresponds to June)
Start of recovery period	2010
End of recovery period	2025
Discount Rate (in per cent)	8
Profit margin (in per cent)	5

ANSP Conventional Technology Decision Process

Option selected for all equipment items*: "Keep until the end of transition period"*.

ANSP New Technology Decision Process

Table 6: Installation Date- New Technology

Location	**Equipment**	**Installation Date**
MUSCAT/SEEB INTL	AMHS	1/01/12
MUSCAT/SEEB INTL	AMSS Voice/Data	1/01/08
MUSCAT/SEEB INTL	GBAS	1/01/09
MUSCAT/SEEB INTL	ADS-B	1/01/10
MUSCAT/SEEB INTL	ADS-C (Workstation)	1/01/10

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Table 7: Fleet forecasts and cost per hour by aircraft type

Aircraft Type	Cost per hour	Fleet Forecast																			
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
B-737-4	1637	45	47	48	49	51	52	54	56	57	59	61	63	64	66	68	70	73	75	77	79
DC-9-50	1804	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	5
A300-600	3533	32	33	34	35	36	37	38	40	41	42	43	45	46	47	49	50	52	53	55	56
B-767-3/ER	3074	42	44	45	46	48	49	51	52	54	55	57	59	60	62	64	66	68	70	72	74
B-777	3838	47	48	50	51	53	54	56	58	60	61	63	65	67	69	71	73	75	78	80	82
B-727-2	2409	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	4	4
DC-10-4	5057	9	9	9	9	10	10	10	11	11	11	12	12	12	13	13	13	14	14	15	15
MD-11	4780	10	10	10	10	11	11	11	12	12	12	13	13	14	14	14	15	15	16	16	17
B-747-4	6176	80	83	85	88	91	93	96	99	102	105	108	111	115	118	122	125	129	133	137	141
ATR-42	598	16	16	17	17	18	18	19	20	20	21	21	22	23	23	24	25	26	26	27	28
A330	3500	68	70	72	74	77	79	81	84	86	89	91	94	97	100	103	106	109	112	116	119
A320	3500	56	57	59	61	63	64	66	68	70	73	75	77	79	82	84	87	89	92	95	98
A310	3500	50	51	53	54	56	58	59	61	63	65	67	69	71	73	75	77	80	82	84	87
C130	2500	23	24	25	25	26	27	28	29	29	30	31	32	33	34	35	36	37	38	40	41
A340	3500	21	21	22	23	23	24	25	26	26	27	28	29	30	31	31	32	33	34	35	36
K35R	1500	6	6	6	6	7	7	7	7	8	8	8	8	8	9	9	9	10	10	10	10
B757	5000	6	6	6	6	6	7	7	7	7	7	8	8	8	8	9	9	9	9	10	10
IL18	4000	6	6	6	6	6	6	7	7	7	7	7	8	8	8	8	9	9	9	9	10
C17	2500	4	5	5	5	5	5	5	5	6	6	6	6	6	6	7	7	7	7	7	8
AN12	1500	4	4	4	4	5	5	5	5	5	5	5	6	6	6	6	6	7	7	7	7
AN24	1500	4	4	4	4	5	5	5	5	5	5	5	6	6	6	6	6	6	7	7	7
SH7	1000	4	4	4	4	4	5	5	5	5	5	5	5	6	6	6	6	6	7	7	7
T154	1200	4	4	4	4	4	4	5	5	5	5	5	5	5	6	6	6	6	6	6	7
BA11	1200	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	5	5	5	5
IL76	3000	2	2	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4
GLF4	2500	2	2	2	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4
C135	1500	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	4	4
P3	1000	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	4
UH1	800	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3
NIM	500	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3
B707	1500	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3
Other types	500	27	28	28	29	29	30	30	31	32	32	33	34	34	35	36	36	37	38	39	39

Table 8: Flight hours forecasts by aircraft type

Aircraft Type	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
B-737-4	32992	33981	35000	36051	37132	38245	39395	40576	41792	43045	44339	45668	47037	48448	49901	51400	52941	54531	56165	57851
DC-9-50	1888	1947	2004	2064	2125	2189	2256	2323	2392	2464	2539	2613	2692	2773	2856	2941	3029	3123	3216	3312
A300-600	23496	24203	24928	25676	26445	27237	28056	28899	29764	30659	31579	32524	33500	34507	35540	36605	37704	38836	40003	41203
B-767-3/ER	30917	31844	32800	33784	34797	35843	36916	38024	39165	40340	41549	42796	44080	45404	46765	48168	49613	51101	52635	54213
B-777	34290	35317	36379	37469	38595	39752	40944	42172	43437	44740	46083	47467	48891	50356	51867	53421	55027	56676	58376	60128
B-727-2	1512	1556	1604	1652	1701	1752	1804	1859	1915	1972	2032	2092	2156	2220	2285	2355	2427	2499	2573	2651
DC-10-4	6308	6496	6692	6892	7100	7312	7532	7757	7989	8229	10476	8732	8995	9261	9540	9827	10123	10427	10739	11060
MD-11	6941	7149	7364	7587	7813	8048	8288	8539	8795	9059	9331	9611	9899	10195	10500	10816	11140	11475	11819	12172
B-747-4	58731	60492	62308	64176	66101	68084	70128	72232	74397	76629	78931	81296	83736	86248	88836	91500	94245	97072	99987	102984
ATR-42	11648	11996	12356	12728	13109	13501	13908	14324	14755	15197	15653	16123	16605	17104	17619	18147	18691	19252	19829	20424
A330	49659	51146	52683	54261	55891	57565	59293	61072	62904	64792	66733	68736	70800	72924	75109	77364	79685	82076	84539	87075
A320	40603	41820	43075	44365	45699	47068	48480	49936	51435	52976	54565	56203	57888	59627	61413	63256	65155	67108	69123	71196
A310	36221	37309	38428	39581	40768	41992	43252	44549	45885	47261	48680	50140	51644	53195	54789	56435	58125	59869	61667	63516
C130	16957	17467	17989	18531	19085	19659	20248	20856	21483	22125	22789	23475	24179	24901	25651	26420	27212	28028	28868	29733
A340	15195	15651	16117	16603	17100	17613	18141	18685	19245	19824	20419	21032	21661	22312	22981	23672	24381	25112	25867	26643
K35R	4340	4469	4604	4741	4884	5032	5181	5339	5499	5661	5832	6008	6188	6373	6564	6763	6964	7173	7388	7611
B757	4152	4277	4405	4539	4675	4813	4957	5108	5260	5419	5580	5748	5920	6099	6283	6469	6664	6864	7069	7283
IL18	4059	4180	4304	4435	4565	4704	4845	4989	5140	5293	5453	5616	5787	5957	6139	6323	6512	6707	6908	7116
C17	3189	3285	3384	3485	3589	3699	3808	3923	4040	4163	4285	4416	4548	4684	4824	4971	5117	5272	5429	5595
AN12	2965	3053	3147	3240	3339	3437	3540	3645	3756	3868	3984	4104	4228	4355	4485	4620	4757	4900	5048	5200
AN24	2955	3043	3133	3228	3324	3424	3525	3632	3741	3853	3971	4088	4212	4339	4468	4603	4740	4883	5028	5180
SH7	2900	2988	3076	3171	3264	3363	3464	3568	3675	3784	3899	4013	4136	4260	4387	4517	4653	4795	4939	5085
T154	2765	2851	2933	3021	3115	3205	3301	3403	3504	3611	3717	3828	3944	4061	4184	4309	4437	4572	4709	4851
BA11	2048	2109	2173	2237	2307	2373	2445	2520	2595	2672	2755	2836	2920	3008	3099	3192	3288	3387	3488	3592
IL76	1736	1788	1843	1896	1955	2012	2072	2136	2200	2267	2333	2404	2476	2549	2627	2704	2787	2869	2956	3044
GLF4	1717	1771	1821	1876	1933	1992	2051	2112	2176	2240	2308	2379	2448	2523	2597	2676	2756	2837	2924	3012
C135	1504	1549	1596	1644	1693	1744	1796	1851	1907	1964	2021	2083	2147	2211	2276	2344	2413	2485	2563	2637
P3	1469	1515	1560	1605	1653	1704	1756	1808	1861	1917	1976	2035	2096	2157	2224	2291	2357	2429	2501	2579
UH1	1373	1416	1459	1501	1548	1595	1643	1691	1741	1795	1848	1904	1960	2020	2080	2141	2205	2272	2340	2411
NIM	1299	1339	1379	1419	1461	1507	1549	1597	1644	1693	1747	1797	1852	1907	1964	2024	2084	2147	2211	2277
B707	1245	1283	1323	1360	1403	1444	1485	1532	1579	1624	1675	1724	1776	1828	1884	1940	1997	2059	2120	2184
Other types	19765	20160	20564	20976	21395	21821	22260	22704	23157	23621	24093	24576	25068	25568	26080	26603	27133	27676	28229	28795

It should be noted that:

- Table 7 provides the number of aircraft by type operating to, from and over the selected homogeneous ATM area.
- Table 8 provides the flight hours of flights arriving to, departing from and over-flying the selected homogeneous ATM area.
- the cost per hour for each aircraft type shown on the second column of table 7 is an average cost for the total fleet of the aircraft type concerned over the analysis period.

Aircraft Equipage

Start of Equipage Date: 01/01/2015
End of Equipage Date: 01/01/2025

Table 9: Aircraft equipage process and efficiency rates

A/c Type	Avionic	Maximum number of aircraft equipped each year	Efficiency (%)
B-737-4	Package 1	7	3
DC-9-50	Package 1	0	0
A300-600	Package 1	3	3
B-767-3/ER	Package 1	3	3
B-777	Package 1	5	3
B-727-2	Package 1	1	3
DC-10-4	Package 1	2	3
MD-11	Package 1	3	3
B-747-4	Package 1	10	3
ATR-42	Package 1	2	3
OTHERS	Package 1	2	3
A330	Package 1	6	3
A320	Package 1	10	3
A310	Package 1	5	3
C130	Package 1	2	3
A340	Package 1	4	3
K35R	Package 1	1	3
B757	Package 1	1	3
IL18	Package 1	2	3
C17	Package 1	2	3
AN12	Package 1	1	3
AN24	Package 1	1	3
SH7	Package 1	2	3
T154	Package 1	1	3
BA11	Package 1	1	3
IL76	Package 1	1	3
GLF4	Package 1	1	3
C135	Package 1	1	3
P3	Package 1	1	3
UH1	Package 1	0	3
NIM	Package 1	0	3
B707	Package 1	0	3

The flight efficiency rates would in practice vary by aircraft type, its optimum flight level, etc. For simplicity it was assumed, in this particular scenario, to be the same for all aircraft types.

Additional costs

The additional costs below correspond to the change of air navigation procedures and the training of controllers for the ANSP and to the training of pilots for the airspace users.

Table 10: ANSP Additional Cost

Year	Cost
2006	0
2007	5000
2008	7000
2009	5000
2010	6000
2011	5000
2012	6000
2013	7000
2014 and beyond	0

Table 11: Airspace Users Additional Cost

Year	Cost
2006	0
2007	2000
2008	3000
2009	2500
2010	4000
2011	4000
2012	3000
2013	5000
2014	4000
2015	5000
2016 and beyond	0