



AEROSPACE INFORMATION REPORT

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Maintenance Life Cycle Cost Model

RATIONALE

AIR5416 has been reaffirmed to comply with the SAE five-year review policy.

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1. SCOPE

This document describes a life cycle cost model for commercial aircraft composite structure. The term life cycle cost used herein, refers to the airline costs for maintenance, spares support, fuel, repair material and labor associated with composites after introduction into service and throughout its useful life. This document contains the equations that can be programmed into software which is used to estimate the total cost of ownership aircraft, including structure. Modification costs and operating costs are estimated over a specified life (any period up to 30 years). Modification costs include spares holding, training, support equipment, and other system related costs. Annual operating costs include: Schedule interruption, fuel, spares, insurance, and maintenance. Maintenance costs are separated by scheduled maintenance or unscheduled damage, or can be grouped into the typical organizations of line, shop, and hangar maintenance. This Lifecycle Cost allows users to evaluate the impact of Service Bulletins, potential design changes, changes in maintenance programs, or effectiveness of maintenance operations.

1.1 Purpose

This document describes a way to estimate Maintenance Life Cycle Cost (MLCC) using a model that is a consensus among airframe manufacturers, airlines maintenance organizations, and repair stations. The CACRC is co-sponsored by the Air Transport Association (ATA), the International Air Transport Association (IATA), and the Society of Automotive Engineers (SAE), which acts as secretary and publishes documents. Since this document is in the public domain, it can be used by Original Equipment Manufacturer's (OEM), suppliers, and airlines who desire to estimate these costs for internal use or to communicate externally.

Some of the potential changes that can be justified with the MLCC model include: Service Bulletin implementation, design changes during original production, optimization of airline maintenance programs, overhaul turn-times reduction by additional investing in tooling or facilities, reliability improvements, overhaul program justification, additional training justification, or nearly any other component or operational change.

The CACRC goal for this document is to provide:

- a. an educational tool for designers describing life cycle costs,
- b. a tool for use by airlines and OEM with which to carry out trade studies that are representative of the cost of airline maintenance, and
- c. A standard model that is a consensus of the CACRC members that will hopefully lead to a common language spoken by various airlines amongst themselves and to the various OEMs or suppliers.

Since the actual cost must be calculated with many equations, this document is intended to act only as a blueprint or plan for software that can be developed to meet the specific needs of the using companies. The features of such software can vary considerably, so we have tried to suggest desirable options. Sometimes the optional features are enhancements to increase functionality, and sometimes they are desired to accommodate the different methods airlines use to account for cost and/or gather reliability information. In support of this goal, Boeing has created an MS Excel-based file which implements the equations in this document, available from the SAE.

1.2 Background

This task grew out of a concern by the CACRC that the changes identified by the Design Task Group (see Guide for the Design of Repairable, Maintainable and Reliable Composite Structures - SAE Document AE-27) that could reduce airline burdens were economically unjustifiable and were therefore not implemented. Often this was due to a lack of cost data available to the aircraft designer for anything other than original production cost and weight (and associated fuel burn). The Design Task Group then examined the existing LCC models used in design trade studies and discovered that they universally focus on Line Replaceable Units (LRUs). LRUs account for a large portion of airline cost, and are the most unreliable as defined by the commonly used measures of MTBUR or delays and cancellations. However, existing LCC models do not adequately deal with structure, which sometimes is not removable but repaired on the aircraft, and therefore not captured in the usual measures.

This MLCC model focuses on the system life cycle from the airline perspective, especially the operational and support costs. Unlike systems engineering or at aircraft manufacturers, this MLCC excludes costs of research and development, production, retirement and disposal - except as these costs are reflected in the acquisition costs from the airframe manufacturer or in airline overhead. Since this model is intended to reflect the cost to the airline, all costs are from the airline perspective which often differs from the OEM costs. For example, the price of a spare part for the airline may be much different than the manufacturer's cost to produce it or to procure it.

2. REFERENCES

The following publications for a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of the other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1 Applicable Documents

Benjamin Blanchard and Wolter Fabrycky, Systems Engineering and Analysis, pub. 1981, Prentice-Hall, Englewood Cliffs, NJ

Boeing, Dependability Cost, pamphlet, pub. by Boeing 1995.

"Spare Parts = Cost Benefit Management", FAST Number 21, pp. 25-24, Airbus magazine

MIL-HDBK-470A, Designing and Developing Maintainable Products and Systems, 4 Aug. 1997.

"Aircraft Maintenance Cost Reduction", Aerospace Engineering, Jan/Feb. 1996, p. 15-17

SAE Committee on Reliability

ATA Common Spec Dictionary, 1992

2.2 Abbreviations and Acronyms

ATA	Airline Transport Association
OEM	Original Equipment Manufacturer
SAE	Society of Automotive Engineers
CACRC	Commercial Aircraft Composite Repair Committee
MLCC or LCC	Maintenance Life Cycle Cost Model
IATA	International Airline Transport Association
LRU	Line Replaceable Unit
MTBMAS	Mean Time Between Maintenance Action – Scheduled
MTBMAU	Mean Time Between Maintenance Action – Unscheduled
MTBO	Mean Time Between Overhaul
MTBR	Mean Time Between Removal
MTBUR	Mean Time Between Unscheduled Removal

MTBURS	Mean Time Between Unscheduled Removal – Scheduled
MTBURU	Mean Time Between Unscheduled Removal – Unscheduled
MTTF	Mean Time To Failure
MTTR	Mean Time To Repair
QPA	Quantity per Aircraft

2.3 Mathematical Symbols

+	Addition
-	Subtraction
*	Multiplication
/	Division

3. AIRCRAFT MAINTENANCE LIFECYCLE COST MODEL

3.1 General

The airline maintenance process is modeled pictorially in Figure 1. The arrows represent the flow of the aircraft parts or resources through the maintenance system. Locations where repairs or overhauls are performed are either on the line, in the hangar, or in the shop. Composites and other aircraft structural elements are often not easily replaced. This can be due to the lack of spares, the lack of interchangeability between aircraft, or the inability to disassemble. All of these may result in the aircraft being taken out of service and possibly ferried to a maintenance base. The MLCC Model attempts to simulate the elements of the whole system, with inputs that airlines already typically use either for business reasons, or for reporting reliability of aircraft or components.

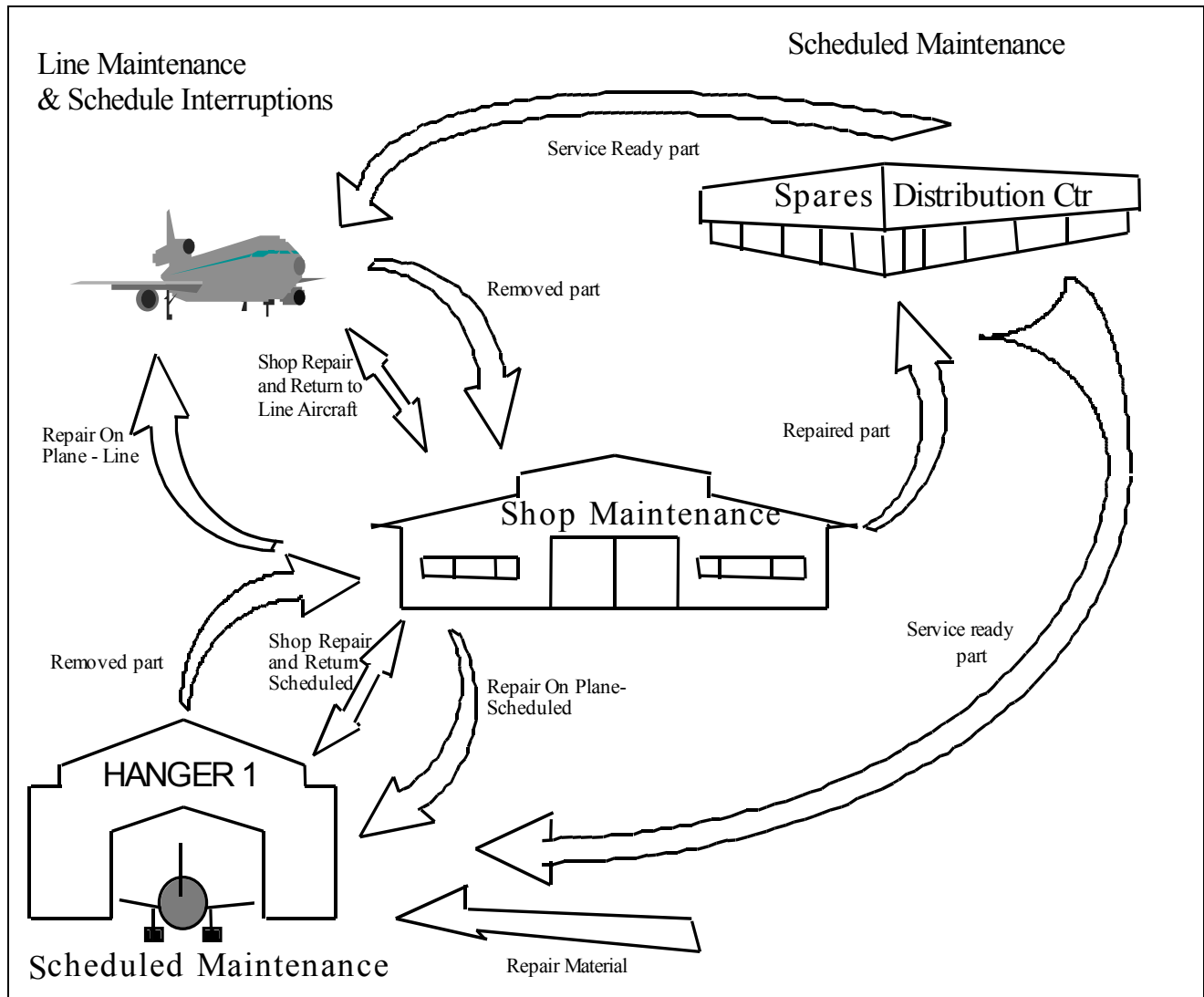


FIGURE 1 - AIRLINE MAINTENANCE LIFECYCLE PROCESSES

Figure 2 shows the cost elements organized into the major categories commonly reported in a typical airline. The MLCC equations (see Section 5) are structured following this model. The dashed lines within the Maintenance category indicate the typical locations where repairs are performed: line, scheduled, or shop. Scheduled maintenance is the tasks required by the maintenance program: and are typically performed in a hangar. Unscheduled maintenance is any unplanned tasks such as: damage caused by FOD, lightning, truck, hail or bird impact.

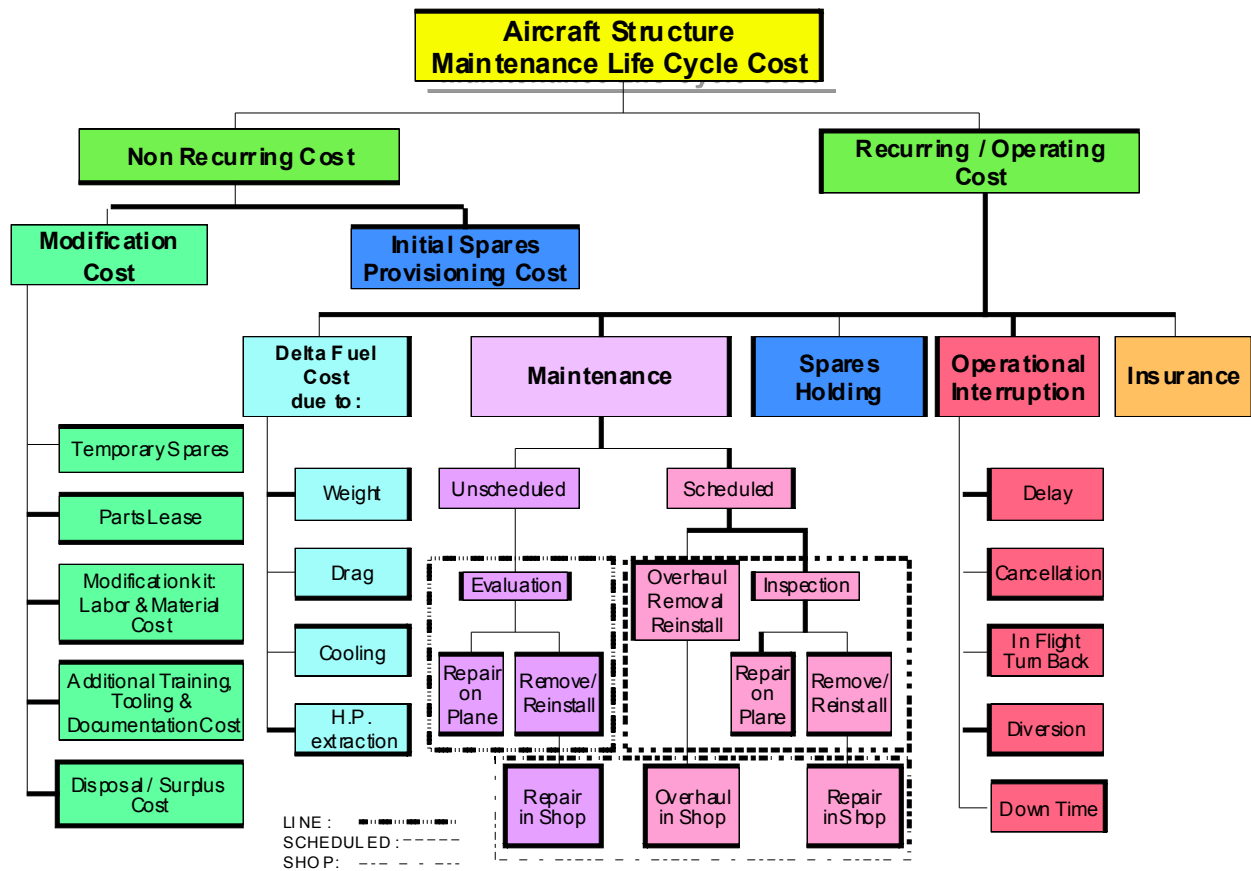


FIGURE 2 - MAINTENANCE LIFE CYCLE COST ELEMENTS

Figure 3 shows the relationships between the failure rates. Adherence to industry definitions of failure rates was made where they exist (MTTF, MTBR, MTBUR, MTBO, MTBMA). New terms MTBUR (U), MTBUR (S), MTBMAU have been defined to cover all possible incidences related to structure. The explanation of these is provided in section 3.4.

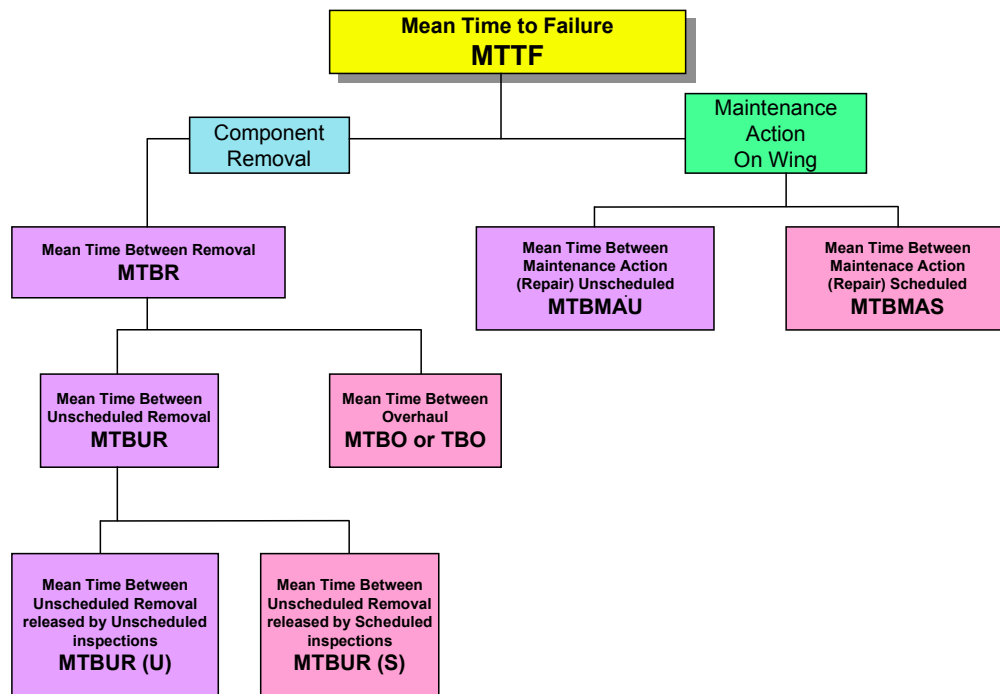


FIGURE 3 - RELATIONSHIP OF FAILURE RATES

Ideally, the model has attempted to provide for multiple ways of reporting costs of spares. For example, the cost of spares can be estimated using Fill Rates and Poisson distribution (ref. 1. p.473-476, and ref. 3), or the actual numbers of spares can be input, or if no spares are purchased then the average annual lease cost can be input. Replacements of some flight controls require a test flight, a cost that should be included along with labor, material, and out-of-service time.

The spreadsheet multiplies all operating cost inputs by inflation rates. The Capital Cost inputs are reported in the current year, so that any expenditure in future years must be converted to net present value. This must be calculated off-line.

3.2 Definition of Equations

The following equations describe the cost elements as organized in Figure 2. They are listed in order of appearance in Figure 2, top to bottom, left to right. The units for each term are in parentheses, such as (dollars/day). Brackets are used for grouping operations, such as [labor cost to install each kit (dollars/kit) + material cost for each kit (dollars/kit)]

ASSUMPTIONS: In general, all cost elements are defined in annual (per year) increments. Events are input per year. Mean Time Rates can be changed into events per year by multiplying the Mean Time Rate by the total annual unit fleet flight hours. Example: To convert MTBUR to a number of events per year:

$$\text{Events} = 1/\text{MTBUR} * \text{fleet flight hours per year} * \text{quantity per aircraft}.$$

Equations defined below do not account for inflation (fuel & non-fuel). The software applies inflation, as applicable (see section 3.3).

3.2.1 Modification Cost Equations

NOTE: Modification Cost is usually considered as a one time or up front cost associated with the implementation of a change from a baseline configuration.

3.2.1.1 Modification Cost

Temporary Spares Cost (dollars)
+ Modification Downtime Costs (dollars)
+ Modification Kit Labor and Material Cost (dollars)
+ Additional Training, Tooling & Documentation Costs (dollars)
+ Disposal / Surplus Costs (dollars).
= Modification Cost (dollars)

3.2.1.2 Modification Downtime Cost

System Modification Days Out-Of-Service (days/aircraft)
* Fleet Size (aircraft)
* Planned Out-of-Service cost per day (dollars/day)
= Modification Downtime Cost (dollars)

3.2.1.3 Modification Kit Labor & Material Cost

Modification Kits Required (kits)
* {Scheduled Burdened labor rate (dollars/hour)
* Installation hours (hours)
+ [Modification Kit Cost (dollars/kit)
* (1+ Material Handling Factor (percent))]}
= Modification Kit Labor & Material Cost (dollars)

3.2.2 Operating Cost Equations

3.2.2.1 Operating Cost

Fuel Cost (dollars/year)
+ Maintenance Cost (dollars/year)
+ Spares Holding Cost (dollars/year)
+ Operational Interruption Cost (dollars/year)
+ Insurance Cost (dollars/year)
= Operating Cost (dollars/year)

3.2.2.2 Fuel Cost

Weight Cost (dollars/year)
+ Drag Cost (dollars/year)
+ Cooling Cost (dollars/year)
+ Power Extraction Cost (dollars/year)
= Fuel Cost (dollars/year)

3.2.2.3 Weight Cost

Weight (Newton/part)
* Quantity per Aircraft
* Fleet Size (aircraft)
* Average Flights per Year per Aircraft (flights/year)
* Average Hours per Flight (hours/flight)
* Fuel burn factor-weight (liter/hour/Newton)
* Fuel Price per Liter (dollars/liter)
= Weight Cost (dollars/year)

NOTE: Fuel burn factor-weight (liter/hour/Newton) = liters of fuel consumed per flight hour per Newton of added weight.
Newton of added weight ($\text{kg} \cdot \text{m/s}^2$) equals mass (kg) times gravity (9.81 m/s^2).



3.2.2.4 Drag Cost

Fleet Size (aircraft)
* Average Flights per Year per Aircraft (flights/year)
* Average Hours per Flight (hours/flight)
* Fuel burn factor-drag (liter/hour)
* Fuel Price per Liter (dollars/liter)
= Drag Cost (dollars/year)

NOTE: this is the difference in cost due to changes in total fuel consumption and is used only when making a comparison between two designs.

3.2.2.5 Cooling Cost

Fleet Size (aircraft)
* Average Flights per Year per Aircraft (flights/year)
* Average Hours per Flight (hours/flight)
* Fuel burn factor-cooling (liter/hour)
* Fuel Price per Liter (dollars/liter)
= Cooling Cost (dollars/year)

NOTE: this is the difference in cost due to changes in total fuel consumption and is used only when making a comparison between two designs.

3.2.2.6 Power Extraction Cost

Fleet Size (aircraft)
* Average Flights per Year per Aircraft (flights/year)
* Average Hours per Flight (hours/flight)
* Fuel burn factor-power extraction (liter/hour)
* Fuel Price per Liter (dollars/liter)
= Power Extraction Cost (dollars/year)

NOTE: this is the difference in cost due to changes in total fuel consumption and is used only when making a comparison between two designs.

3.2.3 Maintenance Cost Equations

3.2.3.1 Maintenance Cost

Unscheduled Cost (dollars/year)
+ Scheduled Cost (dollars/year)
= Maintenance Cost (dollars/year)

3.2.3.2 Unscheduled Cost

Damage Evaluation/ Troubleshooting (dollars/year)
+ Repair on plane (dollars/year)
+ Remove/Reinstall (dollars/year)
+ Repair in Shop (dollars/year)
= Unscheduled Cost (dollars/year)

3.2.3.3 Unscheduled Damage Evaluation/Troubleshooting

Unscheduled Events per year (events/year)
* Damage Evaluation/Troubleshooting Labor Hours per Unscheduled Event (hours/event)
* Unscheduled Burdened Labor Rate (dollars/hour)
= Damage Evaluation/Troubleshooting (dollars/year)

NOTE: Unscheduled Damage Evaluation/Troubleshooting is the time to evaluate and troubleshoot anomalies found after an unscheduled inspection during flight operations, such as a pilot walk-around, or by truck driver after impact, or other ground crew. Unscheduled inspection also includes paperwork, and the evaluation to determine an allowable defect does not need repair. This inspection is primarily due to NDI but may include extra inspections to evaluate the need for a repair. Optionally, the user may include this in the repair time of the three items below and use zero here.

NOTE: Unscheduled damage evaluation/troubleshooting events per year (events/year) = $[1/ \text{MTBMAU} + 1/ \text{MTBURU}]$ (events/flight hours) * average flights per year per aircraft * average hours per flight * fleet size * quantity per aircraft

NOTE: If MTBMAU and MTBURU are not known the user must calculate their values.

3.2.3.4 Repair on Plane

Unscheduled Maintenance Actions per year (events/year)
 * [Labor Hours per Repair on Plane (hours/event)
 * Unscheduled Burdened Labor Rate (dollars/hour)
+ Material Cost per Repair on Plane (dollars/event)]
 = Repair on Plane (dollars/year)

NOTE: Unscheduled Maintenance Actions per year (events/year) = $1 / \text{MTBMAU}$ (events/flight hours) * average flights per year per aircraft * average hours per flight * fleet size * quantity per aircraft

3.2.3.5 Remove/Reinstall (Unscheduled Removals)

Unscheduled Removals per year (events/year)
 * [Labor Hours to Remove & Reinstall (hours/event)
 * Unscheduled Burdened Labor Rate (dollars/hour)
+ Material Cost to Remove & Reinstall (dollars/event)]
 = Remove/Reinstall (dollars/year)

NOTE: Unscheduled removals = $1 / \text{MTBURU}$ (events/part/flight hours * average flights per year per aircraft * average hours per flight * fleet size * quantity per aircraft

NOTE: If MTBURU is not known, the user may input only Unscheduled Events per year.

NOTE: The removal & reinstall time and material is for both actions combined.

3.2.3.6 Repair in Shop (Unscheduled Removals)

Unscheduled removals per year (events/year)
 * [Labor Hours for Shop Repair (hours/event)
 * Shop Burdened Labor Rate (dollars/hour)
+ Material Cost per Shop Repair (dollars/event)]
 = Repair on Plane (dollars/year)

NOTE: The Repair in Shop cost assumes that the parts are removed from the airplane and sent to the shop for repair due to specialized equipment, environment, and skills.

3.2.3.7 Scheduled Cost

Overhaul Removal/Reinstall (dollars/year)
 + Overhaul in Shop (dollars/year)
 + Scheduled Inspection (dollars/year)
 + Scheduled Repair on Plane (dollars/year)
 + Remove/Reinstall (dollars/year)
+ Repair in Shop (dollars/year)
 = Scheduled Cost (dollars/year)

3.2.3.8 Overhaul Removal/Reinstall

Overhaul removals per unit flight hours (events/part/flight hours)

$$\begin{aligned}
 & * \text{Quantity per Aircraft} \\
 & * \text{Fleet Size} \\
 & * \text{Average Flights per Year per Aircraft} \\
 & * \text{Average Hours per Flight} \\
 & * [\text{Labor Hours to Remove \& Reinstall (hours/event)}] \\
 & * \text{Scheduled Burdened Labor Rate (dollars/hour)} \\
 & + \text{Material Cost to Remove \& Reinstall (dollars/event)} \\
 & = \text{Overhaul Removal/Reinstall (dollars/year)}
 \end{aligned}$$

NOTE: Number of overhauls / unit flight hours = 1 / MTBO. MTBO is the actual unit flight hour between overhauls, For example, a Thrust Reverser with 25 000 hard-time overhaul cycles maybe removed at 24 500 hours, which is the MTBO.

3.2.3.9 Overhaul in Shop

Overhaul removals per unit flight hours (events/part/flight hours)

$$\begin{aligned}
 & * \text{Quantity per Aircraft} \\
 & * \text{Fleet Size} \\
 & * \text{Average Flights per Year per Aircraft} \\
 & * \text{Average Hours per Flight} \\
 & * [\text{Shop Labor Hours per Overhaul (hours/event)}] \\
 & * \text{Shop Burdened Labor Rate (dollars/hour)} \\
 & + \text{Overhaul Material Cost (dollars/event)} \\
 & = \text{Overhaul in Shop (dollars/year)}
 \end{aligned}$$

NOTE: (number of overhauls / unit flight hours) = 1 / MTBO.

3.2.3.10 Scheduled Inspection

$$\begin{aligned}
 & \text{Scheduled Events per Year (events/year)} \\
 & * \text{Labor Hours per Inspection (labor hour/event)} \\
 & * \text{Scheduled Burdened Labor Rate (dollars/labor hour)} \\
 & = \text{Scheduled Inspection (dollars/year)}
 \end{aligned}$$

NOTE: Scheduled Inspection events per year (events/year) = $[1 / \text{MTBMAS} + 1 / \text{MTBURS}]$ (events/part/flight hours) * average flights per year per aircraft * average hours per flight * fleet size * quantity per aircraft

If MTBMAS and MTBURS are not known the user must calculate the interval in years.

Inspection intervals related to flight hours equals:

$$(1/\text{interval}) * \text{average flights per year per aircraft} * \text{average hours per flight} * \text{fleet size} * \text{QPA}.$$

Inspection intervals related to time period equals:

$$(12/\text{inspection period in months}) * \text{QPA} * \text{fleet size}.$$

3.2.3.11 Scheduled Repair on Plane

$$\begin{aligned}
 & \text{Maintenance Actions Scheduled per year (events/year)} \\
 & * [\text{Labor hours per repair on plane (hours/event)}] \\
 & * \text{Scheduled Burdened Labor Rate (dollars/hour)} \\
 & + \text{Material Cost per Repair on Plane (dollars/event)} \\
 & = \text{Scheduled Repair on Plane (dollars/year)}
 \end{aligned}$$

NOTE: Maintenance Actions Scheduled per year (after scheduled inspection) (events/year) = $1 / \text{MTBMAS}$ (events/part/flight hours) * average flights per year per aircraft * average hours per flight * fleet size * quantity per aircraft

3.2.3.12 Remove/Reinstall Cost (Unscheduled Removal after Scheduled Inspection)

Unscheduled Removals after Scheduled Inspection per Year (events/year)
* [Labor Hours to Remove & Reinstall (hours/event)
* Scheduled Burdened Labor Rate (dollars/hour)
+ Material Cost to Removal & Reinstall (dollars/event)
= Remove/Reinstall Cost (dollars/year)

NOTE: = Unscheduled Removals per year (after scheduled inspection) (events/year) = 1 / MTBURS (events/part/flight hours) * average flight hours per aircraft per year * fleet size * quantity per aircraft

3.2.3.13 Repair in Shop (Unscheduled Removal after Scheduled Inspection)

Unscheduled Removals after Scheduled Inspection per Year (events/year)
* [Labor Hours for Shop Repair (hours/event)
* Shop Burdened Labor Rate (dollars/hour)
+ Material Cost Shop (dollars/event)
= Repair in Shop (dollars/year)

3.2.4 Spares Holding Cost Equation

3.2.4.1 Spares Holding Cost

Initial Total Spares Cost (dollars)
* Spares holding factor (per year)
= Spares Holding (dollars / year)

3.2.4.2 Initial Total Cost of Spares

Number of spares
* Spares Cost.
Initial Total Cost of Spares

3.2.5 Fleet Operational Interruption Cost Equations

3.2.5.1 Delay Cost

Delay Minutes per Year
* delay cost per delay (dollars/minute)
= Delay Cost (dollars/year)

3.2.5.2 Cancellation Cost

Total Cancellations per Year for that Part (events/year)
* Cancellation Cost for each Cancellation (dollars/event)
= Cancellation Cost (dollars/year)

3.2.5.3 In-Flight Turn Back Cost

In-Flight Turn Backs per Year for that Part (events/year)
* Cost per In-Flight Turn Back (dollars/event)
= In-flight Turn Back Cost (dollars/year)

3.2.5.4 Diversion Cost

Diversions per Year for that Part (events/year)
* Cost per Diversion (dollars/event)
= Diversion Cost (dollars/year)

3.2.5.5 Downtime (Out-of Service) Due to Failures Cost

$$\begin{aligned} & \text{Average Days Down per Year for that Part (events/year)} \\ & * \text{(Unplanned) Out-of-Service Cost per Day (dollars/day)} \\ & = \text{Downtime due to Failures Cost (dollars/year)} \end{aligned}$$

3.2.6 Insurance Cost Equation

3.2.6.1 Insurance Premium Cost

$$\begin{aligned} & \text{Entire Modification Cost (dollars)} \\ & * \text{Insurance Factor (dollars of premium/ dollars of modification/year)} \\ & = \text{Insurance Premium Cost (dollars/year)} \end{aligned}$$

NOTE: The increase in insurance premium due to the modification which increases the value of the aircraft.

NOTE: If the analysis is going to address a Net Present Value then all of the Total Operating Cost must be multiplied by the yearly inflation factor for each year.

3.3 Definition of Variables

"Variables" as used in this document are independent inputs in the equations, and the variables are defined below. They are listed in the order that they appear in the equations, and are so grouped under the major headings shown in the Cost Elements (Figure 2). A variable maybe used by more than one equation. To allow for many different scenarios, inputs are defined for many of the variables, some of which are not needed for simple case studies.

The units for each term are in parentheses, such as "(dollars/day)". To find where variables appear or are defined, use the index.

Before gathering inputs and using the MLCC, the user should review the definitions of variables so that the correct meaning is understood, and the correct units are used.

NOTE: The model calculates all costs on an annual basis. All inputs should be normalized to an annual interval. The time period for the events data should be consistent with the time period of the flight hours data.

3.3.1 Airplane Fleet Variables

3.3.1.1 Airplane Program [Input 1]

This entry documents the name of the airplane model or program under evaluation.

3.3.1.2 Engine Model [Input 2]

This input reflects the type of engine installed on the airplane model. It may be representative of more than one type of engine contained within the fleet. This variable is required only if the system being analyzed is engine related.

3.3.1.3 Aircraft Fleet Size (Number of Aircraft) [Input 3]

This input reflects the number of airplanes in the fleet under evaluation. It should be the number of aircraft affected by the proposed change. It will be unique for each operator.

3.3.1.4 Average Number of Flights per Year per Plane (Flight/Year) [Input 4]

This input is representative of a fleet average or unique to a particular operation and is expressed as the average flights per year for each plane in the fleet.

3.3.1.5 Average Flight Hours per Flight (Hours/Flight) [Input 5]

This input is representative of a fleet average or unique to a particular operation and is expressed as the average flight hours per flight.

3.3.1.6 Average Delay Cost per Delay Minute (dollar/event) [Input 6]

This input represents loss of revenue from a delay to a scheduled revenue flight and is expressed as the average delay cost per minute.

3.3.1.7 Average Cancellation Cost per Cancellation (dollar/event) [Input 7]

This input represents loss of revenue from the cancellation of a scheduled revenue flight and is expressed as average cancellation cost per cancellation.

3.3.1.8 Average Air Turn Back Cost per Turn Back (dollars/event) [Input 8]

This input represents loss of revenue from an air turn back of a scheduled revenue flight and is expressed as the average air turn back cost per air turn back.

3.3.1.9 Average Diversion Costs per Diversion (dollars/event) [Input 9]

This input represents loss of revenue from a diversion of a scheduled revenue flight and is expressed as the average diversion cost per diversion.

3.3.1.10 Out of Service Cost per Day (dollars/day) [Input 10]

This input represents the costs (loss of revenue and/or opportunity cost) associated with the time the aircraft is out of revenue service (such as while modifications are being performed, or for planned or unplanned maintenance).

3.3.1.11 Fuel Burn Factor – Weight (Liter/flight hour/Newton) [Input 11]

This input is unique to each aircraft type. It is the amount of extra fuel burned in liters per flight hour due to changes operational empty weight.

3.3.2 System Modification Variables

3.3.2.1 System Name [Input 12]

This is created by the user to describe the system being analyzed.

3.3.2.2 Year of Modification (calendar year) [Input 13]

This represents the calendar year when the total acquisition cost occurs. For simplicity, the model assumes all costs occur in the first year. The operating costs will then be escalated for each year of the designated system life (any whole number up to 30 years) using a non-fuel inflation factor & discount rate.

Any modification costs must be entered in the same monetary year monetary value as the Year of Modification. If these costs are known for a year different they must be escalated (or de-escalated) before entering the program, which the user must calculate separately. The compound interest formula below may be used for escalation to the desired year.

$$\text{Cost (FV)} = (1+i)^Y * \text{Cost (PV)} \quad (\text{Eq. 1})$$