Despite signs of a recovery, the number of younger generation aircraft in storage has increased during 2003 as some airlines have failed and others restructured. Aircraft owners should ensure their assets are correctly managed in order to preserve value and minimise costs of reactivation.

Technical management for stored aircraft

Correct maintenance and management of aircraft during storage is essential to minimise cost and maintain asset value. The number of stored aircraft has peaked in recent years. Many parked and stored aircraft will go back into operation as traffic volumes increase again, but the prime candidates will be those in the best maintenance condition or which can be most easily and economically restored to operational service. Any aircraft which have been incorrectly stored and maintained will have excessive costs, as well as doubts that leave potential buyers and lessees considering more attractive options.

The number of aircraft in storage has exceeded 1,000 units in recent years, and this comprises a mixture of old and young generation aircraft. It was clear that most aircraft would be stored for a long period, and so those that have not had appropriate maintenance for long-term storage were probably regarded as having little chance of operating again. These aircraft may, however, provide a cheap source of components, rotables and engines.

Length of storage

The two main objectives of storage are to maintain the aircraft's airworthiness from a maintenance point of view and to maintain its value using appropriate maintenance programmes.

"Generally, lessors follow original equipment manufacturers' (OEMs) maintenance programmes, while airlines follow their own tailor made procedures, which often exceed the ones specified by the OEMs," explains Jerry Rodriguez, manager of customer service at the Evergreen Air Center.

The length of storage fits into four categories. "The first is storing the aircraft in a ready-to-fly condition, so it can be prepared for service in a short length of time," explains Matko Dadic, deputy technical director at EBS Maintenance; located at Chateauroux Airport, France. "The second is short-term; lasting up to one week. The third is prolonged storage, lasting one to two months; and the fourth is 24 month storage, the longest and requiring the most extensive maintenance."

Short-term and prolonged storage is often used while aircraft are grounded between leases or for just short seasonal breaks in traffic or for temporary airline problems, such as restructuring or bankruptcy. They may also be used by manufacturers if orders for aircraft are cancelled when they are part-built on the production line and new customers or operators have not been found, or when airlines seek a temporary delay in delivery.

Long-term storage is for a term exceeding two months, and should always be the chosen management if the

The objective of aircraft storage is to preserve airworthiness and market value. Different maintenance procedures are required for different lengths of storage. If the length of storage is uncertain, a long-term storage maintenance plan should be practiced to prevent the cost of reactivating the aircraft being excessive.

length of storage is uncertain. If storage maintenance is inadequate, the asset value will be excessively diminished and the work to return the aircraft to service will be expensive, and probably uneconomic. This will create an imbalance between the cost of returning the aircraft to operation and its value. The value of the aircraft will go into a downward spiral, making it less likely that it will return to service.

Rodriguez explains that long-term storage procedures have the effect of mothballing the aircraft and a series of checks are performed at specific intervals, for example every week, month, 60 days, 90 days and six months. "Engines can also be mothballed so that their oil and fuel systems are drained, and a preserving oil is put into the engines." If engines are mothballed they are left for a whole year.

If the aircraft is not mothballed, a maintenance programme is used so that engines are run every 28 days. If the engines are stored so that they are run every 28 days their fuel and oil systems are not drained. "Running engines every 28 days is quite expensive, but is done to keep oil circulating and some airlines and lessors prefer this," explains Rodriguez.

Category of storage

The maintenance procedures during storage are described in air transport association (ATA) chapter 10 for aircraft stored by airlines and ATA chapter 21 for aircraft stored directly from the production line by manufacturers. "If aircraft are stored under chapter 21 then the maintenance procedures that have to be followed are determined by the original equipment manufacturers of the major components. That is, airframe, engine, auxiliary power unit (APU) and landing gear manufacturers," explains Dadic. "If the aircraft is stored under chapter 21 the manufacturer decides which length of storage to perform. Operators or lessors decided the length of storage under chapter 10."

Storage procedures

To begin with, water has to be drained from all places in all types of storage, including toilets and galleys. Presence of water leads to mildew.

Aircraft in short-term storage, lasting only up to one week, should be parked in a protected environment to avoid overheating from the sun. EBS at Chateauroux Airport installs a special material on the windshield and cabin windows to protect from discolouration.

The aircraft is anchored, in case of adverse winds, and pitot tubes and engine intakes and exhausts are also covered. The battery is also disconnected to shut down the aircraft.

"Aircraft in prolonged storage have the same treatment as for short-term, and in addition have regular lubrication of flight controls and landing gears, since they may dry out while parked for up to two months," says Dadic. "Protection of unpainted areas is required with a special lubricant protector LPS3. The battery is again disconnected, but no components are removed. The fuel tanks, however, need to have some fuel in them to prevent the sealant on the inner tank walls drying out. Airbus aircraft need to have their tanks up to 90% full, while Boeing aircraft only require tanks to be about 15% full. The amount of fuel has to be given special consideration, however, since it can affect the landing gear."

Aircraft kept in a ready-to-fly condition receive the same treatment as for prolonged storage, but the engines and APU are also run every 15 days and systems are tested frequently to keep the aircraft in a ready-to-fly condition.

Long-term storage requires more comprehensive preparation.

"An induction check is performed prior to long-term storage, and this is a fairly large check. All items that will be performed later in seven day, 30 day, 60 day and 90 day checks are carried out, as well as lubrication of all flight controls and landing gears," says Rodriguez.

All emergency equipment is removed, the same protection for shorter term storage is given to the aircraft, all passenger and cargo doors, ventilation outlets, and air conditioning intakes and outlets should be sealed. All drains should be kept clear. Windows are blanked from the outside to prevent bleaching of the seats and interiors by the sun.

"Most or all avionics are also removed during long-term storage, and put in an avionic equipment store. There are also special procedures for engines; the actual one depending on engine type," explains Dadic. "Tyres are also deflated by about 10% to reduce shaping while the aircraft rests on them for a long period. The most important issue is keeping maintenance records on all components, because the cost of replacing those that do not have records will be high. Records for aircraft owned by a leasing company will be kept by a subcontracted engineering company."

Maintenance procedures

"Some items on the aircraft have to be removed according to Chapter 10 procedures," explains Rodriguez. "Individual customers may want more components removed, and these might be avionics, for example. Damage by salt in the atmosphere is the worst type of possible damage during storage, and this is why induction and regular checks are performed. One of the reasons why Arizona is an ideal environment for storage is the low humidity and level of salt in the atmosphere. Salt can very quickly lead to corrosion in the airframe.

Evergreen performed a study of the effects of improper and correct storage, and determined that improper storage is a false economy.

"It can cost up to $10,000 for every month an aircraft is stored to rectify corrosion that has built up under an improper storage programme," says Bill Whelan, director of heavy maintenance

Corrosion of airframes during storage incurs huge costs at reactivation, and can make it uneconomic to do so. It is a false economy not to take maximum protection against corrosion even for periods of storage lasting less than one year.

sales at Evergreen Air Center. "We have had relatively young aircraft corroded to point of it being uneconomic to reactivate them for operation due to improper storage. Corrosion prevention and control programme inspections are performed when the aircraft is reactivated for going back into service. The contents of the reactivation check is devised when the aircraft is inducted into storage."

"The treatment for components is documented in the maintenance programme," says Rodriguez "Some are life-limited, although airlines may be able to have the lives of some components changed."

The calendar lives of emergency equipment and other components on the aircraft can expire during storage. Most parts have lives of 4-10 years; landing gears having some of the longest lives. The cost of replacing these components therefore increases with term of storage, and so also raises the cost of making the aircraft serviceable when leaving storage. The cost can be lowered by acquiring components on the aftermarket, but can be in short supply for popular and younger aircraft. The cost of replacing parts and components can therefore be excessive, and make returning the aircraft to operation uneconomic.

The list of other items that have to be considered is quite detailed. Oxygen bottles, for example, have to be weighed each year. The aircraft may also have to be prepared for a ferry flight following storage so that it can be sent to an appropriate maintenance facility following storage.

"The regular inspections performed on the airframe for long-term storage are light for weekly visits, and get progressively larger," says Rodriguez. "The weekly inspections are basically visual, and used to check for leaks. Larger checks are used to check for the build up of moisture and mildew, as well as operate flight controls and the APU, and run all airframe systems. This is so that the aircraft is kept ready for a normal state of operation, and effectively keeps the whole of the aircraft working."

Reactivation

Besides the reactivation check determined when the aircraft entered storage, a heavy check may be due to calendar time expiry, or be close to being required. The cost of a heavy check will be offset against the aircraft's value. A large portion of components may also require replacing or maintenance at reactivation.

The aircraft owner may have also removed engines during storage and leased them out, or used them for other aircraft in its fleet. This runs the risk that there will be no engines with significant time remaining to a shop visit left. This will add to the cost of reactivation. The total cost can be excessive compared to the aircraft's value. The rentals of leasing out engines, will however, offset the costs of storage and reactivation.

The reduction in value during storage will, however, be minimised by storage procedure by minimising maintenance required. "Maintenance records before and during storage have to be kept by the storage facility," explains Rodriguez. "The records for reactivation maintenance are then handed over to the customer. The storage facility or another maintenance facility may do the reactivation maintenance. The problem is that some components will have expired and so the aircraft cannot fly to another facility until these are replaced. Aviation authorities allow dispensations for others to be replaced at an alternative maintenance facility after the aircraft has been flown from the storage facility. When the aircraft leave the storage facility, however, all safety items except evacuation slides for passenger doors have to be working. The only slide that has to be working is one for pilot emergency evacuation."

Airworthiness directives (ADs) and service bulletins that are issued while the aircraft is in storage may or may not be performed during the storage maintenance procedure. Those due on a calendar basis will have to be performed during reactivation maintenance, although others can be left until later maintenance checks. Other ADs will have expired during storage and have to be terminated during reactivation maintenance.

In addition to reactivation maintenance, owners or buyers will have to consider the costs of interior refurbishment and/or major modifications such as conversion to freighter. The length of storage and change in economic climate may be such that demand for a certain type has reduced and values and lease rates fall to a level that makes reactivation uneconomic. The risk of this is higher with widebodies, and the DC-10 and 747-100/-200s have particularly suffered during the recent downturn. There can still be a high value from salvaging components from the aircraft, especially for engines, landing gears, avionics and interiors. AC