Line maintenance involves a large volume of checks for each aircraft in a fleet. It requires coordination of flight operations, flight schedules, ground operations, maintenance planning and maintenance production. The organisation of line maintenance and cost of line checks are examined.

Managing the process of line maintenance

Line maintenance accounts for a large portion of an aircraft's total maintenance costs, although its importance is often overlooked. While line and ramp checks consume a small amount of labour, materials and consumables, the large number of such checks required by an aircraft means that small savings in each one can significantly reduce overall maintenance costs. The main focus has been on extending intervals and reducing inputs for major maintenance events, but the lower line maintenance requirements of modern aircraft have helped to reduce their total maintenance requirements.

Line maintenance requirements

Line maintenance programmes for aircraft types are generically similar, but the maintenance planning documents (MPDs) of modern generation aircraft specify fewer tasks and checks compared to older types. "Some modern aircraft do not have pre-flight (PF) or transit (TR) checks in their MPDs, but these are still performed either voluntarily or because an operator's local authority requires them," explains Matko Dadic, sales manager at Europe Aviation.

Line maintenance programmes revolve around aircraft operations, which are either short- or long-haul. Most airlines operate from one or a few main hubs or operational bases, with sub-fleets based at each one.

Short-haul operations are flights of up to two hours. Aircraft typically perform five to eight flights per day, generating 2,500-3,000 flight hours (FH) and 1,500-2,000 flight cycles (FC) per year. Most operations start early in the morning and finish late at night. Aircraft spend each, or every second, night at their home base.

Long-haul operations have flight times of 6FH or more. Aircraft generate up to two FC per day, or up to 700FC per year, and 4,500-5,000FH per year. Aircraft leave their home bases on an outbound leg to an outstation, and return home after a 2-4 hour turnaround. This results in an average daily utilisation of 12-14FH. It is hard for aircraft to generate more FH per day.

In more recent years, with the advent of types like the A340-500 and 777-200LR, ultra-long-haul operations have emerged, with flight times of 10FH or longer. Singapore Airlines' (SIA) Singapore-New York service with the A340-500 has a flight time of 17FH. Most carriers can only schedule 1.0-1.5 ultra-long-haul sectors per day.

A daily check can be performed at a maximum interval of 48 hours in most cases, so it is possible to have virtually all daily checks performed at an operator's home base. This is preferable because this is where their maintenance control centres, inventories of spare rotables and consumables, and teams of line mechanics and engineering teams are based. Daily checks can be performed by third parties, but this is a more expensive option. Aircraft used for ultra-long-haul operations are more likely, however, to have daily checks performed after each flight, or at least have a relatively heavy PF check carried out by a line mechanic at an outstation.

"Line mechanics completing the daily checks sign a release-for-service form, so that the aircraft can then be freed for operation. A PF check is then done before the first flight of the day," explains Dadic.

A PF check on modern aircraft types is a visual inspection performed by the flightcrew in most airlines. The content of PF checks in the MPDs of older aircraft was larger, and was either performed by the flight engineer in aircraft with a three-man flightcrew or by a licensed mechanic.

After the PF check and first flight, most line and ramp maintenance programmes specify a TR check before all subsequent flights during the day.

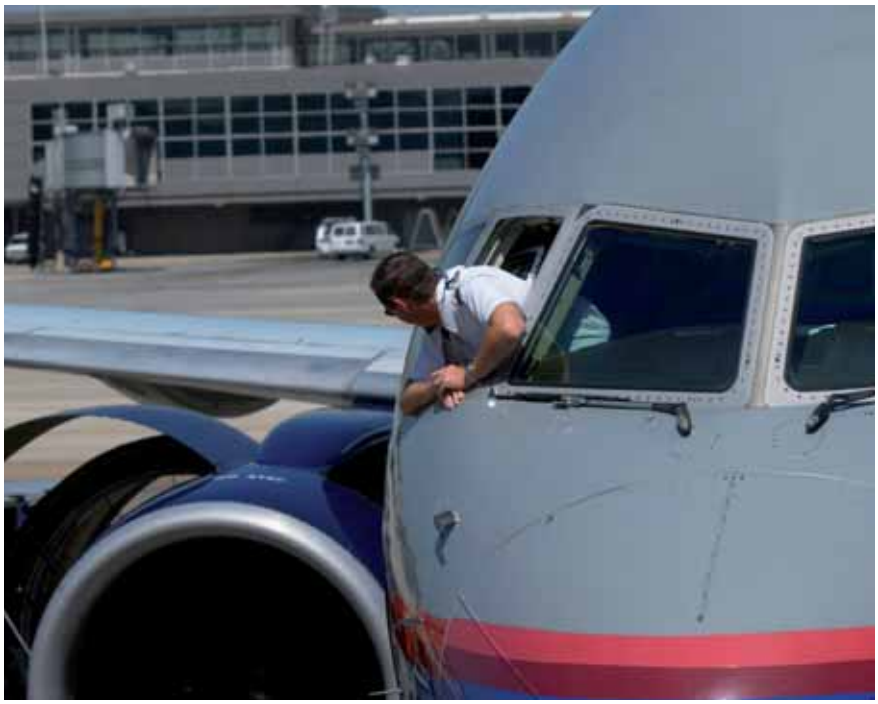
Short-haul aircraft completing six FCs in a day will have a daily check, a PF and five TR checks. "The routine tasks for the PF and TR checks are all visual inspections. While a few defects may occur, unless they are 'no-go', they can be deferred until at least the daily check, so PF and TR checks can be performed by flightcrews in the case of most airlines," explains Dadic. "This leaves the heavier daily and higher checks to be performed by line mechanics".

Daily checks are performed at night on short-haul aircraft, so are referred to as overnight checks by some airlines.

Long-haul aircraft have a daily check at their home base prior to operation, followed by a PF check. These checks can often be completed on the ramp at the airport terminal, and are performed at varying times of the day according to the airline's schedule. The aircraft will usually have a TR check at the outstation before returning home.

"Even though the maintenance programme only needs a TR check to be performed by the flightcrew, the length of long-haul flight times and the complexity of added features in cabin management systems, in-flight entertainment (IFE) systems and lie-flat seats mean that several defects often arise. Line mechanics may therefore have to be available to perform maintenance after each flight," explains Dadic. "Daily and PF checks are often performed prior to each flight on ultra-long-haul operations, because airlines require high comfort margins in aircraft technical dispatch reliability and cabin and IFE systems. These areas are important to airlines when they want to protect their goodwill with high-yield premium-class passengers."

The weekly check is the next higher line check, with an interval of seven or eight days in most MPDs and maintenance programmes. Its content



The routine tasks in pre-flight and transit checks consist of visual inspections. While these checks were traditionally done by line mechanics, they are now carried out by flightcrew members in most airlines. Any defects that have to be rectified requires a mechanic, but most can be deferred until higher checks.

exceeds the daily check, but airlines use the weekly check to perform several extra tasks and clear some deferred defects.

Total check requirements

Airlines will perform four to five daily checks and one weekly check in a week of operations. Aircraft will operate for an average of 350 days or 50 weeks per year, once public holidays and downtime for base maintenance are considered.

A short-haul aircraft completing 2,500FH and 2,000FC per year will carry out an average of 7.15FH and 5.7FC in each day of operation. The aircraft will therefore have 350 PF checks and 1,650 TR checks per year, together with 250 daily checks and 50 weekly checks.

A long-haul aircraft, operating at average FC times of 8FH, might generate 4,750FH and 600FC per year. When operating for 350 days per year, it would generate 13.5FH and 1.7FC each day in service. The aircraft would have 50 weekly and 250-300 daily checks, and 250-300 PF checks. It would therefore have another 300 TR checks. The number of checks by line mechanics might increase, and the number of TR checks fall, as a precaution to maintain high aircraft technical dispatch reliability (TDR) and reliability of cabin systems.

Line & ramp check contents

Line check workscopes comprise several elements, including routine tasks specified by the MPD or the certified maintenance programme. These can often be added to by an airline's own additional requirements. "There are also a few tasks without specified intervals, so individual operators must decide when to schedule them," explains Dadic. "Airlines therefore develop and modify their own line maintenance programmes."

Non-routine tasks or correction of defects can be required as a result of the aircraft's operation, or due to findings as a result of the routine inspections.

Airlines will also add items relating to the aircraft's interior. While cleaning can be done by contractors, airlines will also do minor rectifications and maintenance to interior items on an on-condition or as-required basis. Larger interior tasks can be deferred or rectified according to the airline's preference. Service standards often force airlines to rectify items during turnarounds at outstations.

PF & TR checks

The PF and TR checks are the lightest checks, and are visual external and internal inspections of modern aircraft. "Flightcrew can only do the check if they are suitably qualified. We now have flightcrew instead of line mechanics doing PF and TR checks on new types like the A320 family and the E-170/-190, so we need fewer MH for line maintenance," explains Janne Tarvainen, assistant vice president aircraft maintenance at Finnair Technical Services.

If flightcrew are not prepared or qualified to do PF and TR checks, or the workscopes are larger than the MPD inspections, the checks must be done by line mechanics. "Using line mechanics for PF and TR checks is more common with older aircraft, since some of the visual inspections include checking fluid and lubricant levels, which have to be replaced more often," says Dadic. "If flightcrew find fluid levels need to be replenished at an outstation they can inform their local handling agent, which can provide line mechanics to do the work, or contact a local line maintenance company."

The routine content of PF and TR checks is similar. Some additional items in these checks are for aircraft certified for extended range twin-engine operations (Etops). These are small items, such as changing of oil filters.

In the case of the A330, for example, the routine tasks in the PF check are a list of visual inspections intended to verify the overall condition of the aircraft, and that the visible components and equipment are safe for flight. A PF check has to be completed within two hours of departure. Most tasks are listed in the walkaround inspection, including a visual inspection of: pitot tubes; lights; ice detectors; external bay doors and access panels; wheels and tyres; landing gear structure and shock absorbers; landing gear hydraulic lines and wiring; antennas; fluid and water level indicators; engine fan cowl doors; slats and flaps; engine inlets and outlets; engine pylons; the removal of safety pins; wings; fuselage; and general aircraft condition.

The PF check includes some routine interior inspections, such as operational checks on: the HF radio equipment; fire and overheat detectors; engine and auxiliary power unit (APU); and the flightdeck crew oxygen system. Engine oil levels and the condition of internal emergency equipment are checked via the on-board maintenance computers.

The aircraft's technical log has to be checked for outstanding technical defects, to verify that no defects will affect the next flight, there are no no-go defects on the list, and no minimum equipment list (MEL) items have exceeded their legal deferment time. Once completed, the check is then signed for in the aircraft's technical logbook.

The contents of the TR checks repeat about half of the items in the PF check. The technical logbook is also checked, and any new defects are added to it.

Daily checks

The daily check includes the PF checks and additional tasks for line mechanics, combining external visual inspections and interior inspections.

On the A330, the external visual

Daily and weekly checks are the lowest line checks performed by line mechanics. The total workpackage of daily checks requires 4-6 man-hours for most types, and weekly checks use 7-10 man-hours.

inspections include the fuselage, tail and empennage, engines and pylons, wings, doors, engine oil, and landing gear and wheels. "Other items include manually checking tyre pressures, and brake disc wear pins to verify if brake disc thicknesses are within legal limits. Daily checks comprise visual inspections on other items, such as shock absorbers and flight controls," says Dadic.

Internal checks include hydraulic fluid levels and APU oil levels. "These can be done from flightdeck instruments. There are legal limits, so they can sometimes be replenished at later checks," says Dadic.

Other internal items include checking passenger doors, the flyaway kit of rotables, and emergency equipment.

Items such as brake disc thicknesses and fluid levels are recorded by the mechanics so that maintenance planning engineers can decide when to remove brakes and replenish fluids as part of the line check planning process.

"Daily checks include the additional cabin tasks an airline needs to maintain service standards," says Tarvainen.

The aircraft's technical and cabin logbooks are also checked. Besides cabin cleaning and other interior checks, rectifying defects is also included, but this involves items that must be cleared within a few days. All other defects are deferred until weekly or A checks.

Weekly checks

Weekly checks have larger workscopes than daily checks, and are daily checks plus additional items. "Additional items include the examination of magnetic chip detectors in engines, landing gear equipment, oil levels in the integrated drive generator (IDG), waste water drainage in the galleys, and emergency-door gas bottles," says Tarvainen. "Weekly checks are often done at night for short-haul aircraft."

The additional external items involve checking the landing-gear actuation pistons and cargo compartment doors. Additional interior items are a category III landing capability test, a test of the elevator servo controls, and inspection of the emergency door slides and other emergency equipment.

"Besides routine tasks and clearing defects, several other groups of tasks are included in weekly checks," continues Tarvainen, "such as checking and testing cabin and interior systems, updating software and flight operations data with downloads, and performing minor modifications."

Additional requirements

TR checks following long-haul flights often include more than just routine tasks because several defects can occur over a long flight. Airlines can keep line mechanics available, but they can also use flightcrew for the routine part of the check and rely on handling agents or third-party maintenance providers for on-call assistance. "We offer on-call assistance, whereby we supply a line mechanic within a specified time to clear no-go defects," says Dadic. "On-call assistance can be charged at a fixed rate."

Another additional requirement to routine line maintenance is aircraft-on-ground (AOG) situations, where large no-go defects occur, resulting in long downtimes and rectification by a large team of mechanics. Examples are an engine change after a birdstrike, a major avionic failure requiring a unit on the flightdeck to be replaced, or physical damage to the aircraft. "A fleet of 35-40 aircraft will probably suffer one AOG situation per week during the summer season," says Dadic. "Another way is to say that aircraft on average have one or two AOG events per year, although they do of course occur at random."

Airline operations

Line and ramp checks are not only required to perform routine tasks, but also to deal with technical defects as they occur during operation at random. They vary from simple items such as the failure of light bulbs to the malfunctioning or failure of major system components. Most rotable components on modern generation aircraft are maintained on an on-condition basis, and aircraft are designed to allow easy access to these components for inspection, removal and replacement, usually during line checks.

Some rotable components are classified as no-go items, meaning their failure prevents further operation of the aircraft until rectified. These defects cannot be deferred. Examples are a failure of primary avionics and flight instruments, engines or pilot seats.

Aircraft have an MEL of items that must be operational for the aircraft to fly. There is also a list of items whose defects can be deferred for a specified amount of calendar time without aircraft operation being halted. "There are four categories of time for which the defect can be deferred: 24 hours, 48 hours, 10 days and 90 days," says Dadic.

All line and ramp checks have calendar intervals, but the higher A checks have FH intervals. Many defects are deferred for rectification until A checks. A check intervals are 500-700FH for most aircraft types, so they are performed every 350-600FH. These intervals must be considered in relation to aircraft utilisation on a calendar and FH basis, so that defects are not deferred for longer than their legal calendar interval. Flight and technical logs of aircraft utilisation and technical defects therefore must be kept, and the two must be monitored so that planning the clearing of defects can be co-ordinated.

Flightcrews used to manually write flight and technical logs, but this process has since been automated by flight management systems (FMS), so that flight

Items such as brake disc thicknesses have to be monitored so that removal for repair and overhaul can be anticipated and planned at convenient checks, such as a daily or weekly check.

logs can be transmitted electronically to maintenance systems. The objectives are to achieve the highest possible intervals between maintenance checks, cause minimal downtime and disruption to the operation, and avoid high costs for rectifying defects with unscheduled line and ramp checks.

Some defects require extensive downtime. The aircraft must be placed in a hangar, and mechanics with specific skills and licenses, and particular rotables and tooling are all necessary to rectify the defect. As these are only usually all available at the operator's home base, it is best to clear these defects during convenient daily, weekly and A checks. No-go or 24-hour MEL defects that occur when the aircraft is away from base will force rectification, requiring on-site assistance, which can be expensive.

Technical defects must initially be analysed, usually by flightcrew during operation in the first instance. Some defects can easily be analysed, while more complex problems with system items result in fault codes being displayed on the aircraft's system monitoring screens.

Faults not detected by fault codes must be noted manually by pilots. All faults detected by pilots are recorded in pilot reports (PIREPs) and technical logs. Complex faults and codes have traditionally been analysed and isolated by line mechanics using fault isolation (FIM) and troubleshooting manuals after the aircraft has landed.

This process takes place in airline maintenance operations control (MOC) or maintenance control centre (MCC) departments by line mechanics. Because analysis and rectification of defects can require extensive time and resources, and cause long delays, MOC and MCC departments should be notified as soon as defects occur. The aircraft crew and reporting system (ACARS) that transmits fault codes and messages to MOC and MCC departments gives line mechanics lead time to determine if faults can be deferred, or immediate action is required. Pilots can also report defects by radio.

Fault analysis has been simplified by the evolution of on-board maintenance systems. Line mechanics collect all fault messages from aircraft after each flight, and check hand-written PIREPs and technical logs. On-board maintenance systems have evolved to include all relevant analysis manuals, so that analysis can be made on the flightdeck.

Production planning

Various maintenance systems collect and co-ordinate aircraft flight and technical logs, technical defects, and maintenance programmes and plans. These systems first allow line mechanics to analyse the faults and decide whether to rectify or defer them. Maintenance planning engineers then decide in which checks defects should be rectified.

Planning maintenance tasks and checks in relation to aircraft utilisation has traditionally been a manual task, but various maintenance softwares now offer the capability of automating line check planning. An example is MXi's Maintenix. "We have added a module to Maintenix to automatically plan line checks to save a lot of time that is used manually to plan line maintenance," says Richard Halliday, product manager for Maintenix at MXi. "This starts with the airline's flight plan and available maintenance slots. The typical planning horizon is five days, and the module automatically packages maintenance tasks once it knows actual aircraft utilisation and location, and the availability of maintenance facilities, labour skills, tooling and parts. These are then optimised according to the aircraft's maintenance programme and check intervals. The module compares rates of aircraft utilisation and task intervals.

"Some tasks and other factors, such as service bulletins (SBs) cannot be planned automatically," continues Halliday. "The automation process proposes a check plan, but it also lists things that cannot be scheduled, such as tasks that require particular labour skills or certain parts if it is not known when they will be available. These can be replanned manually when their availability is known. It also lists all items that still have to be planned manually.

"The first step is the proposal of a workpackage that is actually possible, followed by a list of things that cannot be planned automatically. Once these manual issues are dealt with, the maintenance plans are sent to supervisors at the various line maintenance facilities, and everything that can be planned is executed. Findings and non-routines must be dealt with and planned manually," explains Halliday. "The system therefore must know the maintenance programmes and flight schedules of each aircraft type, the aircraft utilisation and FH and FC used, and all information about maintenance facilities and resources. This new module is expected to produce savings of 80% in engineering time for the planning of line maintenance and an improved utilisation of maintenance intervals. The main issue is about the control and availability of the line maintenance plan."

Resources

Several resources are required to manage and complete line checks.

The first is suitably qualified line mechanics and additional management staff. "After line mechanics, engineers are necessary for troubleshooting and analysing faults as they occur in operation, for maintaining logs and maintenance records, and for planning the various checks and workscopes," explains Tarvainen. "We have about 10 engineers for our operation, which

Finnair has a comprehensive maintenance operations control organisation. This coordinates technical services with flight operations, ground operations and flight dispatch.

involves a fleet of 70 aircraft. We also have supervisors and about 30 inspectors. We have 410 mechanics, 50 supervisors, 30 inspectors and a few troubleshooting co-ordinators concentrating on difficult and repetitive faults problems. We also have 30 production planners. They take care of line maintenance and A checks for our A340, MD-11, A320, 757, E-170/-190 and ATRs fleets."

"Our fleet is managed by 410 line mechanics working over five or six shifts, which is about 60 fewer than in 2006. We have reduced staffing by 15%, or 100 people, to be more competitive and because our flightcrews now perform a higher portion of PF and TR checks since we modernised our fleet. The PF checks were previously done by line mechanics on our MD-80s and early A320s, for example. Our fleet now includes seven MD-11s and three A340-300s for long-haul operations and a total of 29 A320 family and 14 E-Jets for short-haul and regional operations and seven 757s for charter operations. These mechanics are also required for line maintenance work on our third-party customers' aircraft."

In addition to staff, airlines require an organisation that includes MOC and MCC departments which can co-ordinate with the airline's ground operations, flight operations, dispatch and maintenance and engineering departments. "We manage the flight schedule, flight operations and maintenance plan with software called Scope," says Juha Hiissa, manager of operational line maintenance and line stations at Finnair Technical Services. "This has maintenance tasks and checks programmed into it, and also knows typical ground times required to complete checks. Scope is fed by our maintenance control software, which we have developed ourselves, with fault and defect information, as well as FH and FC logs for each aircraft.

"We also have a network control centre (NCC) which has troubleshooting co-ordinators, follows the outstanding defects on each aircraft, analyses faults and provides remedies," says Hiissa. "The NCC's main function is to keep control of irregularities (technical, catering and ground handling), such as dealing with delays and providing substitute aircraft. Line maintenance must therefore operate around NCC, which uses a system called Delay Cost Management to analyse the various costs of delays and suggest the most economic solution when irregularities arise. The technical supervisor is our link between NCC and line maintenance. Technical operations (which has the responsibility of continuing airworthiness management), a department of maintenance and engineering, tells technical services what it wants and when to maintain the airline's operation. Scope schedules flight operations and maintenance.

"The technical supervisors follow flights and record defects, decide whether to rectify or defer them, and how long for, and decide where and when to fix the aircraft. They also know the line and light maintenance programme," explains Hiissa. "The technical supervisors communicate with the MOC, which gives instructions to team leaders for fixing defects and scheduled line checks."

Operators also require facilities for daily and weekly checks. "Daily and weekly checks, and some light A checks, can be done outside on the ramp," says Dadic. "Some unscheduled tasks might have to be performed in a hangar. Daily and weekly checks are often performed overnight, so it is practical to carry them out in a hangar to protect mechanics from the weather, and to provide warmth and lighting. The European Aviation Safety Agency (EASA) requires all base maintenance, from A checks upwards, to be performed in a hangar."

"We have two hangar bays at Helsinki for weekly checks," says Tarvainen. "We perform four checks per night on A320s, and so 28 per week.

"Tooling is required for brake and wheel changes, tyre-pressure checking and the occasional component change," continues Dadic. "Airlines and maintenance control aim to defer as many component and engine changes to A checks, so they can be done in the hangar where more tooling is available."

Line checks up to weekly checks require a sufficient supply of consumables. "The most commonly used consumables are oil, hydraulic fluids, nitrogen gas to inflate tyres, rags, cleaning agents, and other fluids and lubricants," says Dadic. "A few expendables such as lightbulbs, seat belts, seat covers, washers and caps are also required." These need to be available in plentiful supply, especially at an operator's home base to ensure that the operation is not restricted.

A sufficient inventory of rotable components also has to be available because items and units on the aircraft fail at random. Many of these are no-go items, so will prevent operation if serviceable units are unavailable in the event of a failure. This can occur anywhere across the airline's route network, so the items which fail most often should be analysed to determine the number required, and where to locate spare units without incurring excessive investment in rotable inventories. Since spare items of every rotable component cannot be made available at every outstation an airline flies to, arrangements can be made with local suppliers or other airlines to borrow or lease rotables for pre-agreed fees. Some airlines also operate with a flyaway kit of some rotable items. These can be fitted by the local maintenance provider or handling agent in the event of a failure.

Third party line maintenance

Line maintenance, maintenance operations control, and engineering

Finnair has developed its own software system called Scope to manage and coordinate its flight schedule, flight operations and maintenance plan.

management that overlaps with line maintenance have traditionally been performed in-house by airlines. However, these services can be sub-contracted to third-party providers. European Maintenance Solutions (EMS) is a joint venture formed in early 2007 by three European line maintenance companies: Stella Aviation of The Netherlands; European Aviation of France; and Louro Aircraft Services of Portugal. "EMS was set up to provide a complete range of line maintenance services and activities. These include all types of line checks and lighter A checks, logistics support, and engineering support. We offer line maintenance and A check maintenance services for the 737 family, 757, 767, 777 and various 747 models. We also have the A320 family, A300, A310, A330 and A340 within our capability, as well as the MD-11 and DC-10," explains Johan Megan, commercial director at EMS. "These services are on offer at 35 airports, 27 of which are European. The rest are African, Caribbean and South American."

"EMS has teams of line mechanics, and facilities for line maintenance at all 35 of these airports. EMS also has a maintenance control centre in Amsterdam, and European Aviation has bases at Orly and Chateauroux, providing 24-hour maintenance control services," says Megan.

EMS also offers its customers AOG and on-call assistance, engine and heavy component change capability, and logistics services in providing materials, consumables and full rotable support for airlines if they require it. An example is a contract it has with Northwest Airlines to provide all the rotables and materials it requires for its European 757 and A330 operations. Megan explains that these are managed at Amsterdam from Stella Aviation's maintenance control centre. Parts can be shipped within three hours to any airport within a 200-mile radius.

"Rotable support is an important part of full line service provisioning, so we offer a full service in co-operation with rotable specialist AJ Walter," explains Megan. "We are used by several airlines, which can sub-contract their whole line maintenance operation to us, so they can employ a minimum number of people and use the minimum resources, or select any services from the long list we offer."

Line check inputs

The inputs needed for line maintenance are direct labour, materials, consumables and the associated cost of the management system. There are overheads for facilities, tooling, hangars and equipment. The overheads for the management system for line maintenance and all the associated facilities are an element of burdened labour cost.

While rotables are removed and replaced throughout an aircraft's annual operation, their associated costs of ownership, management and repair are budgeted and accounted for as a cost element related to components.

The only main costs that have to be considered therefore are man-hours (MH) and consumables and materials. As explained by Tarvainen, the MH an airline requires from its line mechanics can be reduced when PF and TR checks are performed by flightcrew instead of line mechanics. Although the labour input for these checks was only one or two hours, the large number of checks performed generated several hundred MH each year. "When we switched from line mechanics to flightcrew the labour saving meant we needed a smaller team of line mechanics," says Tarvainen. "Line mechanics are now only required to clear defects at the odd PF and TR checks, and also for the daily and weekly checks.

"The cost of labour for PF, TR, daily and weekly checks accounts for 90-95% of the cost of the checks, and inputs of materials and consumables are low," continues Tarvainen. "With short-haul aircraft like the MD-80, the older generation required only 30 minutes for PF/TR checks for routine tasks and the total check. There was little or no non-routine, since this could almost always be deferred until the daily or weekly checks. Daily checks then required 1MH for routine tasks and 2MH for the whole check. The MD-80 would use 4MH for the routine portion of a weekly check and 6MH for the whole workpackage.

"The A320 fleet has similar requirements, although the routine portions of the PF and TR checks can be done by the flightcrew, which means they use no labour," says Tarvainen.

Using a generic labour cost of $70 per MH, the cost of materials and consumables can be budgeted. Dadic explains that these include engine oil, cleaning materials and fluids, rags, nitrogen and hydraulic fluid. A check using 1MH of labour can use another $5-10 for materials and consumables, while larger daily and weekly checks can use $15-45. A check using 4-6MH can be done by two line mechanics, and have a downtime of 2-3 hours.

"The long-haul MD-11 and A340 both use 1MH for PF and TR checks, while the daily and weekly checks are also similar with no obvious differences between generations of aircraft," says Tarvainen. The MD-11 requires 4MH for routine work and 7MH for the whole package. The labour requirement is larger for the weekly check, which uses 8MH for the routine portion and 10MH for the whole package. The A340 needs only 1MH less for the daily and weekly checks. The cost of consumables and materials is in proportion with the expenditure on short-haul aircraft." AC