Chapter A

MAINTENANCE SCHEDULES

The Scheduled Maintenance tasks recommended throughout this manual are summarized in the tables in this chapter.

If your plant does not have a program of scheduled maintenance and wishes to begin, it is possible to start with these tables, which are in *.XLS files for Microsoft® Excel format, and edit them to your needs. Begin by downloading the files from https://www.pressmanual.online/press-maintenance-schedules/ .

The tables are printed here and saved in two different ways:

- Grouped by **"skills,"** or similar types of work, such as Hydraulic, Electrical, and Combustion, to suit the specialized training of your technicians. This file is saved as **Master Maintenance Schedule**.
- Grouped by **frequency** (daily, weekly, monthly, etc.) PM checks are cumulative, for example the monthly checks would also include all of the daily and weekly items as well. For this reason the **yearly** schedule incorporates all items and is treated here as the master list. This file is saved as **Periodical Maintenance Schedule**

In the spreadsheet format, each task is coded in the far left column according to skill and frequency, to allow easy sorting into groups by using the Sort function of the spreadsheet program. Of course the user may easily change the sort codes or add others for customizing the tables.

Please remember that all of the tasks and frequencies are general recommendations, which will not suit every plant. Actual schedules for each plant should be adjusted, taking into account other factors such as:

- plant maintenance history
- equipment design and options installed
- equipment manufacturers' recommendations
- age and condition of the equipment
- relative cost and urgency of downtime for the plant

You should revise these general ecommendations to suit your actual needs and experience.

Note: These files are saved in Microsoft® Excel 97-2003 Workbook format, for the convenience of users who may not have newer versions of the spreadsheet software, but they may be used with later versions.

When to Perform Extrusion Plant Maintenance

Preventive, Predictive, or Reactive Maintenance?

Waiting until after a failure has occurred is called **Reactive Maintenance**. Others call this "breakdown maintenance." Whatever name is used, it is almost always a bad policy to wait for breakdown to take action, for several reasons:

- Unplanned production downtime occurs
- Overtime for maintenance workers may be required
- Production workers may have to stand idle during emergency repairs
- Because the work is unplanned, necessary skills and materials may not be on hand
- The damage may be worse than if the problem had been repaired earlier

One alternative is **Preventive Maintenance**, which for our purposes will be defined as **interval-based** maintenance, or maintenance which is done at some fixed interval of time, or perhaps some other unit interval such as hours, miles or pounds. Example: changing oil or replacing the timing belt on an automobile, which is based on time or miles. However, for many other items wear is not so predictable based on interval alone, so other factors determine when to perform maintenance.

Predictive Maintenance is defined as **condition-based** and so involves some type of regular inspection or measurement to determine when replacement or maintenance should be done. Examples: replacing automobile tires is based on tread wear; and monitoring cracks in extrusion press tie-rods to determine when replacement is necessary.

In the 1st edition of the Extrusion Press Maintenance Manual we used the term **Preventive Maintenance** to describe the tables of maintenance schedules; but according to the definitions above, most of the schedule items involve checks and so are actually predictive in nature. Perhaps the correct name should be **Proactive Maintenance**, meaning that action is taken before problems occur.

Some Thoughts on the Theory of Component Failures

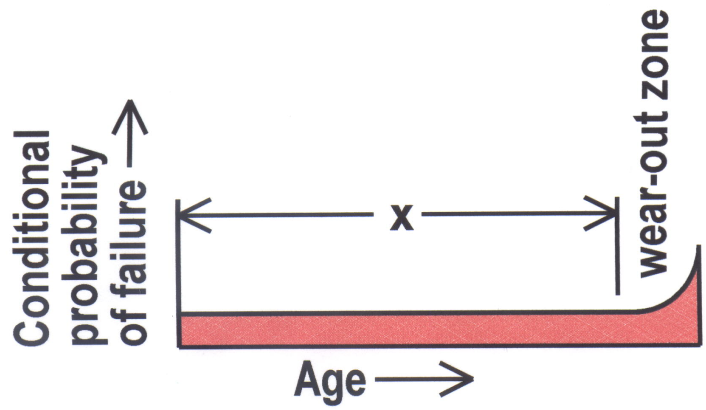

Figure A-1: The traditional "wear out" view of plant equipment.

It is useful to look at the patterns of probability of equipment failure during the life of a component[1]. The pattern in **Figure A-1** describes the classical "wear out" view of plant equipment. The theory is that the interval "x" can be determined from equipment records and used to take preventive action just before failure occurs. This relationship between age and failure tends to be true in certain cases, mainly where product comes in contact with a component, such as containers, dies, and graphite or Kevlar materials on cooling tables. Fatigue of major press components is also age-related.

1. Moubray, John, Aladon Ltd., "Redefining Maintenance", Maintenance Technology, March 1996.

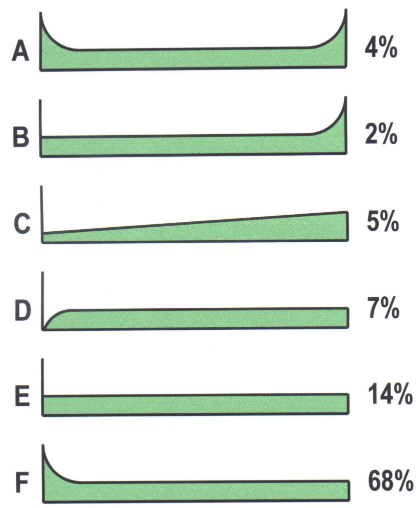

Figure A-2: Six well-defined patterns of equipment failure probability.

However, there are other well-defined patterns of equipment failure probability, as shown in **Figure A-2**. Which of these patterns apply to which extrusion plant components? If you plan to overhaul a component on an interval basis, "just in case" it may be needed, you will need to know which of these patterns applies to that component.

As it turns out, it can be very hard to predict which pattern applies. For example, studies on civil aircraft showed the following distribution of failure patterns:

A 4%

B 2%

C 5%

D 7%

E 14%

F 68%

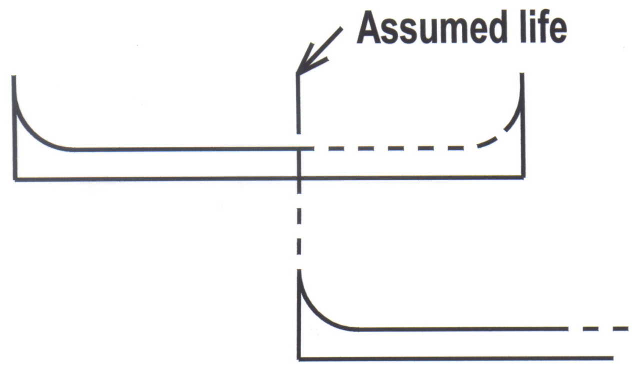

Figure A-3: Overhauling an item "just in case" it might fail after some point creates the possibility that the overhaul itself will cause the item to fail.

While extrusion presses are quite different from aircraft, we can still see from this example that the connection between reliability and operating age is not always easy to predict. And unless there is a clear connection between age and failure, equipment overhauls at fixed interval may not increase reliability. “Overhauls are extraordinarily invasive undertakings that massively upset stable systems[2].” In other words, if it isn’t broken, it may be better to check it than to overhaul it.

Pattern A in **Figure A-2** is often called the “bathtub” because of the upward curves at each end. This is the classic pattern usually predicted for electronic components – high losses during “burn-in,” followed by good reliability until the end. Considering this example, note in **Figure A-3** what happens when such a component is replaced early, “just in case” – the probability of failure is actually increased due to the so-called “infant mortality” of this type of component. Thus we see just one of the possible risks to keep in mind when following interval-based maintenance.

2. Ibid.

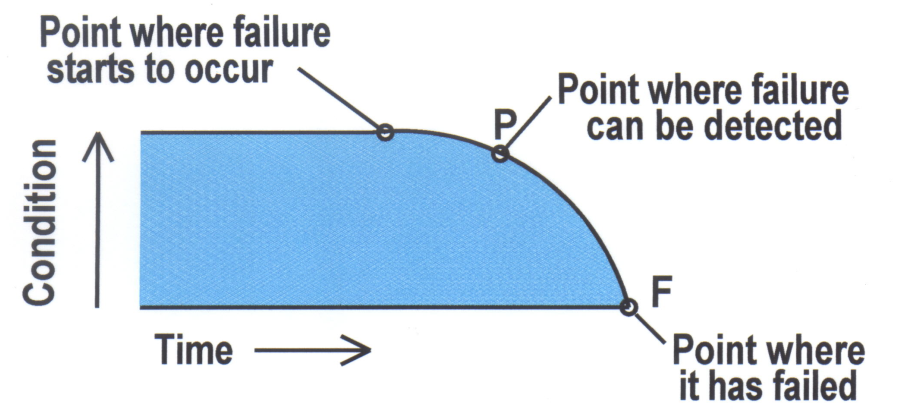

Figure A-4: The P-F curve shows how a failure starts and deteriorates to the point where it can be detected.

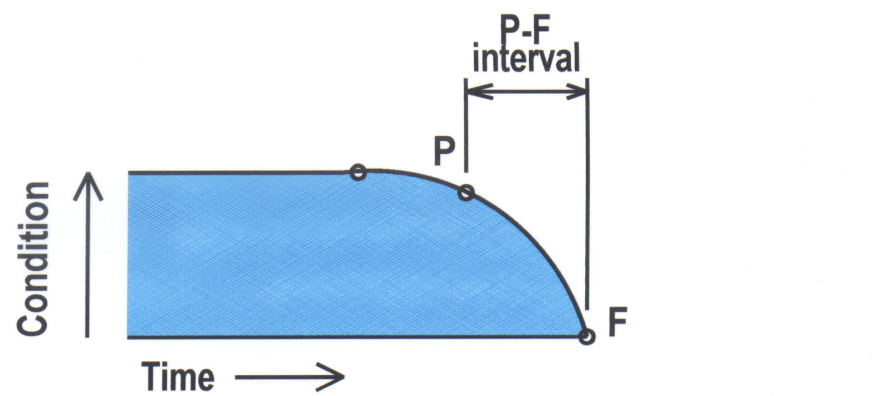

Figure A-5: The P-F interval is the amount of time between the potential failure point and the functional failure point.

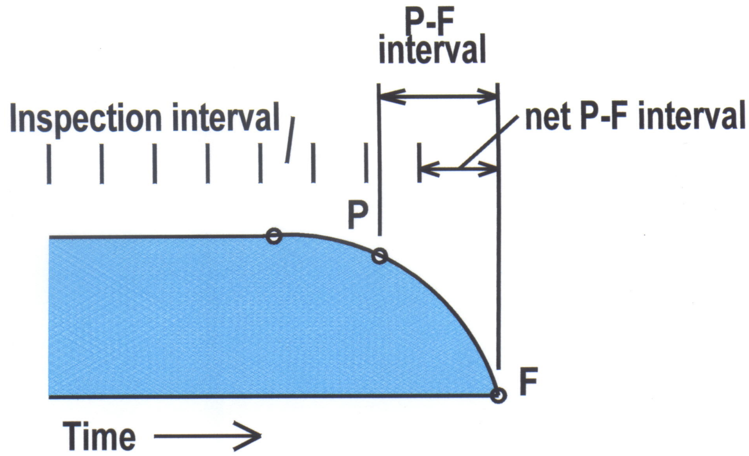

Figure A-6: The net P-F interval is the P-F interval less one inspection interval.

With these limitations in mind, note that most of the Scheduled Maintenance items in the **Maintenance Schedules** actually consist of inspections or checks, and so are condition-based. These are based on the idea that we will be able to detect when failure has just begun to occur, but before it is too late. This concept is shown in **Figure A-4**. The time interval between P, when the failure can first be detected, and F, when complete failure occurs, (**Figure A-5**) is quite important, as it determines the frequency of inspections. To illustrate, consider the inspection interval as shown in **Figure A-6**. It becomes clear that almost one complete inspection interval can pass after the problem shows up before it is actually found. Therefore, the ideal inspection interval is somewhere between ½ and 1 times the P-F interval.

While these concepts help us understand about inspection and maintenance intervals, in practical terms we never have enough information to make informed decisions. We don't know the probability-of-failure pattern, and we don't know the P-F intervals. Therefore we must rely on our past experience and the recommendations of others.

The tables in the **Maintenance Schedules** have been compiled from many sources: prior versions of the manual, vendor's recommendations, and advice from many experienced people. These serve as an excellent starting point or reference for you to construct your own maintenance schedules. The tables are available for download to allow for easy revision to suit your own applications.

The other essential tool for a Proactive Maintenance program is the best possible record of repair histories for each equipment component. With Personal Computer-based record systems, it is now very easy to set up and maintain complete histories, which can then be used to identify recurring repairs and to establish the desired frequency for inspection and/or replacement. Records on a PC may be set up using spreadsheet or database software, or a Computerized Maintenance Management System (CMMS).

A good program of Proactive Maintenance includes regular, scheduled inspections, lubrication, diagnostic tests, and the occasional strategic replacement of wearing parts before they fail. Each scheduled "PM" shutdown will usually include some repairs which have been identified during daily or weekly inspections.

In any extrusion plant, it is vital to have a plan for managing the problems of fatigue failure of major extrusion press components. High-cycle fatigue is an important strategic business concern in every extrusion plant. Without a plan, a major component failure is sure to occur – it is not a matter of "if" but "when." Therefore, every extrusion firm's top management must be concerned with this issue and must insure that a suitable program is in place, to insure against unplanned expenses and major breakdowns. Various firms can offer assistance in setting up and following such a program; one example is Det Norsk Veritas, whose excellent paper on the subject is included in **Chapter 4** of this Manual.