

Chapter 7

Allowance for Personal Time, Fatigue, and Delays (PFD)

7 Introduction

Most of the time studies are collected on employees who are paid an hourly rate of pay. The results of the time study can be used to:

1. Define a “fair day’s work”
2. Determine how different jobs should be paid
3. Determine how difficult the jobs are
4. Determine how varied the jobs are
5. Determine manpower requirements and capacity limitations
6. Provide an objective means of comparing alternative methods for accomplishing a task
7. Provides a basis for wage incentives and evaluating worker performance
8. Provides accurate time data for production scheduling, cost estimating, and other management functions that rely on accurate task time data.

There are two basic ways to pay an hourly employee:

1. Based on the amount of time they work (rate per hour).
2. Based on the number of units they produce (rate per piece of completed work).

Three basic methods for determining time standards include (1) estimation, (2) historical records of previous production runs, and (3) work measurement techniques (i.e., direct time study, predetermined motion time systems, standard data system, or work sampling).

7.1 Daywork

Daywork is when employees are paid an hourly rate of pay regardless of their output. No quotas are established, and production may vary from day to day. Different jobs may be paid different rates of pay based on a variety of factors, such as:

1. The skill required to do the job.
2. The time required to learn how to do the job.
3. The financial impact of decisions made while doing the job.
4. Any other factors considered appropriate by management.

7.2 Measured Daywork

Employees are guaranteed a flat rate of pay for one day's work. A standard quantity of output is also established as being the average output that should be achieved for one

day of work. The standard output is used by management for planning and pricing purposes and to measure the efficiency of the operation daily. However, an employee earns a flat rate of pay every day regardless of their output for that day.

7.3 Standard Hour Plan

Employees are guaranteed a minimum base rate of pay for one day's work. A specific level of output is benchmarked to this rate of pay (target output). If the employee produces that exact amount (or anything less) they are paid the base pay for that job. But for each 1% increase in output over and above the target value, the employee is paid a premium of 1%.

7.4 Piecework

Piecework is the oldest method for paying people for the work they do. A specific amount of money is paid for each unit (piece) that the person completes. If a person produces more output in one day, then they are paid more. If they produce less, they are paid less. But in each case the amount of pay is directly related to the actual work that was done. Time studied standards are a fundamental part of this method of payment because the pay standards must be directly related to the amount of time it should take to do one unit of work (or complete one piece). In the USA, employees are guaranteed a minimum hourly wage even if their daily output is below the quantity required to earn the minimum wage.

7.5 Allowance for Personal, Fatigue, and Delay

In time study, allowances for **Personal Time (P)**, **Fatigue (F)**, and **Delay (D)** are added to the normal time to account for unavoidable interruptions and to ensure that the time standard is realistic and achievable. These allowances help to ensure that workers are not overburdened and can maintain a sustainable pace of work.

In addition to their normal work duties, employees are allowed to spend part of their workday doing other things. The allowance is commonly referred to as personal time, fatigue, and delay allowance (aka PFD allowance). The PFD allowance is calculated in such a way that, if the worker works at 100% performance during the portion of the shift that he or she is working, the amount of work accomplished will be the equivalent of eight hours' worth². The PFD allowance in time standards represents the additional time that is included in the standard time to perform a task that allows for the worker's personal needs, fatigue, and unavoidable delays during the shift. If the standard daily output quota is to be attainable, these activities must be included in the total standard time.

Some reasons why workers experience lost time during a work shift includes:

1. Machine breakdowns
2. Waiting for extra help to arrive at the machine center
3. Waiting on stock, parts, or other items
4. Waiting on supervisory sign-offs before running an order
5. Receiving instructions from the foreman or QC Manager
6. Waiting at the tool crib or parts department
7. End-of-shift cleanup

Non-work-related interruptions or delays include:

1. Tending to personal needs (i.e., rest room, water fountain, Gatorade)
2. Conversing with co-workers about non-work-related things
3. Lunch break or break times
4. Smoke break
5. Personal telephone calls at the workcenter

These other activities are divided into three major categories:

1. Personal Time (P):

- This allowance accounts for personal needs such as restroom breaks, hydration, and other personal activities.
- Typical allowance: 5% of the total time.

2. Fatigue (F):

- This allowance compensates for the physical and mental fatigue that accumulates over time due to the nature of the work.
- Typical allowance: 4-8%, depending on the work's physical and mental demands.

3. Delay (D):

- This allowance covers unavoidable delays such as machine breakdowns, material shortages, and interruptions from supervisors.
- Typical allowance: 2-5%, depending on the frequency and nature of delays in the work environment.

Example 1. Calculating the Allowance Factor for P, F, and D

Personal Time

Personal time refers to that portion of an employee's day during which they attend to their own personal needs.

It includes time for a 10-to-15-minute break in the morning, another break in the afternoon, and an occasional trip to the water fountain and/or to the bathroom during non-break times. Finally, it includes some time at the workstation for personal activities, such as scratching your ear, stretching, adjusting the position of your chair, etc. A typical allowance for this category is 5%. Whereas a larger allowance would be appropriate if the work environment is hot or cold and uncomfortable, a lower allowance would be appropriate for very favorable working conditions.

Calculating Personal Time

The following is an example of how personal time could be estimated using the results of an 8-hour study. Some of the personal activities shown below should be included in the personal time percentage and some of the activities should be omitted. The activities that are omitted are not excluded because they are not personal, but because they are not activities that the company wishes to pay for. As an example, the company normally does not wish to pay its employees to make personal telephone calls. If a personal telephone call is needed, then the company believes the employee should make the call during a lunch period or during one of the normally scheduled breaks. The same concept applies to smoking. Smoking is not an extra activity that the company should pay for. Smoking is an activity the employee should do during a break or during lunch. Breaks are included in the personal time percentage. Lunch periods are sometimes included in the personal time percentage, but most companies do not pay their employees to eat lunch.

Sometimes employees take longer breaks than the company allows. When that occurs, only the official company standard break time is included in the Personal Time calculation. Any extra break time which the employee takes is omitted from the calculation. In the example below, the official company break time is 12 minutes, once in the morning and once in the afternoon.

Activity	Minutes	Decision
Morning break	12.0	Include
Extra time on Morning break	1.3	Omit
Adjust chair seat cushion	0.4	Include

Take a smoke break	6.2	Omit
Visit water fountain	2.1	Include
Eat lunch	30.0	Omit
Afternoon break	12.0	Include
Sneeze (etc.) at workstation	0.9	Include
Visit bathroom	4.0	Include
Use cell phone	7.5	Omit
Total personal time per day	31.4	4 elements omitted

Eight-Hour Workday = 480 minutes

Personal Time Ratio = (31.4 minutes) / (480 minutes) = 0.065 (7.1)

Personal Time Factor = 6.5%

Fatigue Time

Fatigue is the general feeling of tiredness that is accompanied by a physiological change in a person's body with the net result being a decrease in that person's ability to do work.

Fatigue is the body's natural defense mechanism that automatically slows the body down to avoid exhaustion and fainting.

Fatigue Factors

The major factors that influence fatigue are:

1. The length of the workday (eight hours is optimal).
2. The number and duration of rest periods. 10 to 15 minutes rest every two hours is optimal for light work. Heavy work requires more frequent and longer rest periods.
3. The type of work being done (physical or mental, standing or sitting, abnormal body position).
4. The difficulty of the work being done (light work versus heavy work).
5. Mental and cognitive factors such as concentration and vigilance, monotony and tediousness, eyestrain.
6. The prevailing environmental conditions (heat, noise, dust, humidity, lighting, etc.).

Contingency Allowances

Contingency allowances are sometimes added to Apfd, but not as a substitute for it. Contingency allowances are usually applied due to some kind of problem with a task or the production equipment used in the task. Examples include:

1. Starting materials may be out of specification requiring extra time to sort through the batch of materials or to correct the nonconformance.
2. The manufacturing process is not in a state of statistical control and, therefore, requires extra time to inspect each part versus performing random sampling when a process is stable and predictable.
3. The equipment used is breaking down or malfunctioning more frequently than usual and extra time is needed by the worker to make equipment adjustments, lubricate the equipment, and otherwise tend to frequent equipment needs.

Other Types of Allowances

A **machine allowance** is intended to cover special work situations that are typically associated with a wage incentive system. The machine allowance allows the worker an opportunity to maintain high earnings potential even though the worker only has control over a portion of the worker-machine cycle. A **training allowance** may be applied for workers who are responsible for teaching other workers how to do their jobs. A **learning allowance** may be applied for workers who are learning a new job.

Calculating Fatigue Time

Following is an example of how fatigue could be estimated using the results of an 8 hour study:

T1 = Average time to produce one unit during the first hour of work.

T2 = Average time to produce one unit during the last hour of work.

$$F = [(T2 - T1) / T1] \times 0.5$$

The above equation is multiplied by 0.5 to yield the average fatigue time during the day (not the fastest time nor the slowest time, but half-way between those two extremes).

Example

T1 = 0.590 Minutes per unit

T2 = 0.620 Minutes per unit

$$F = [(0.620 - 0.590) / 0.590] \times 0.5 = 0.025 \quad (7.2)$$

Fatigue Time Ratio = 0.025

Fatigue Time Factor = 2.5%

Delay Time

There are two types of delays:

1. avoidable, and
2. unavoidable.

Normally, **avoidable delays** can be anticipated and prevented, and, therefore, they are not included in the standard time. Examples of avoidable delays include scheduled machine downtime, no work due to the temporary shortage of materials, and no work due to bottleneck processes.

Unavoidable delays are predictable, although they may occur at random times. Therefore, they are added to the standard time. Examples of unavoidable delays include interruptions by a supervisor, minor machine malfunctions that can be fixed by the employee, and minor problems with materials that can be overcome using additional employee skill or care.

Calculating Delay Time

The following is an example of how the delay time could be estimated using the results of an 8-hour study:

Activity	Minutes	Decision
Set-up machine (start of shift)	4.5	Include
Wait on materials (minor)	2.3	Include
Wait on materials (major)	52.5	Omit
Supervisor gives instructions	3.8	Include
Talk to best friend	8.9	Omit
Material variations (minor)	2.4	Include
Material variations (major)	37.5	Omit

Adjust machine (minor)	4.6	Include
Mechanic fixes machine (major)	41.7	Omit
Clean up machine (end of shift)	2.1	Include
Total delay time per day	19.7	4 activities omitted

Eight Hour Work Day = 480 Minutes

Delay Time Ratio = (19.7 minutes) / (480 minutes) = .041 (7.3)

Delay Time Factor = 4.1%

The delay factors which were omitted in the above calculation are not ignored by management. However, they are ***not*** added into the time allowed to do a job. The delay factors that are omitted should be kept track of separately daily, and weekly summary reports provided to management so a decision can be made if corrective action is necessary in a specific area. For example, if the total machine downtime for the week is only 5 hours for all the equipment, then management may consider that to be acceptable. But if the total machine downtime for all the equipment for the week is 47 hours, then management may consider that to be excessive and then seek ways to reduce the downtime.

Application of P, F, and D

All three factors are added together to yield the total P, F, and D Factor. This factor is then converted into a multiplication percentage.

This percentage is multiplied by the base time for a job and then added to the original base time to yield the total standard time for a job.

Results

Personal Time Ratio	0.065
Fatigue Time Ratio	0.025
Delay Time Ratio	0.041
Total P, F, and D Time Ratio	0.131

Allowance for P, F and D = [1 / (1 - PFD Ratio)] - 1 (7.4)

Allowance for P, F and D = [1 / (1 - 0.131)] - 1 = [1 / 0.869] - 1 = 0.151

Allowance for P, F and D (Final Percentage) = $0.151 \times 100\% = 15.1\%$, or 15% (rounded)

Proof:

If a time study yielded, say, 0.600 average minutes to do a job, then we would first adjust by our performance rating factor to yield the leveled base time to do the job. Then we would add the P, F, and D percentage to yield the total standard time to do the job, as in the following example:

0.600 = Average minutes per unit
 X 1.05 Performance Rating factor (employee skill)
 0.630 = Base time per unit (for an average employee)
 X 1 = Frequency

 = 0.630 = Normal time per unit
 + 0.095 = P, F, and D allowance time (0.15×0.630)
 0.725 = Total standard time per unit

Proof: $0.095 / 0.725 = 0.131 = \text{Total P, F, and D Time Ratio}$ (7.5)

The allowance for P, F, and D is 15%.

Therefore, when the total normal time per unit is multiplied by 15%, this allows for 13.1% (or $0.131 \times 480 \text{ min} = 62.88 \text{ min}$) of the 8-hour workday for P, F, and D issues.

7.5.1 Apfd Alternative Formula²

An alternative formula for calculating the allowance for P, F, and D is given by:

$$A_{pfd} = \left[\frac{\text{Available time}}{(\text{Available time} - \text{Allowance time})} \right] - 1 \quad (7.6)$$

However, its limitation is that it only considers personal time and delay time. Absent is the allowance for fatigue time as demonstrated using the results from Example 1.

Total personal time per day	31.4	4 elements omitted
Total delay time per day	19.7	4 activities omitted

Example

Personal Time Ratio	0.065
Fatigue Time Ratio	0.025
Delay Time Ratio	0.041
Total P, F, and D Time Ratio	0.131

Allowance for P, F and D = $[1 / (1 - \text{PFD Ratio})] - 1$

Allowance for P, F and D = $[1 / (1 - 0.131)] - 1 = [1 / 0.869] - 1 = 0.151$

Allowance for P, F and D (Final Percentage) = $0.151 \times 100\% = 15.1\%$, or 15%
(rounded)

Example 2. Calculating Apfd with Alternative Formula.

$$\begin{aligned}
A_{pfd} &= \left[\frac{\text{Available time}}{(\text{Available time} - \text{Allowance time})} \right] - 1 \\
&= \left[\frac{480 \text{ min}}{(480 \text{ min} - (31.4 \text{ min} + 19.7 \text{ min}))} \right] - 1 \\
&= \left[\frac{480 \text{ min}}{480 \text{ min} - 51.1 \text{ min}} \right] - 1 \\
&= \left[\frac{480 \text{ min}}{428.9 \text{ min}} \right] - 1 = 1.119 - 1 = 0.119, \text{ or } 11.9\% \neq 15.1\%
\end{aligned}$$

Note that the Fatigue time ratio in Example 1 is 0.025, so

$$\text{Fatigue time} = 0.025 \times 480 \text{ min} = 12 \text{ min}$$

If the fatigue time of 12 min is added to the above personal time and delay time in the above denominator, A_{pfd} becomes:

Proof:

$$\begin{aligned}
A_{pfd} &= \left[\frac{\text{Available time}}{(\text{Available time} - \text{Allowance time})} \right] - 1 \\
&= \left[\frac{480 \text{ min}}{(480 \text{ min} - (31.4 \text{ min} + 19.7 \text{ min} + 12 \text{ min}))} \right] - 1 \\
&= \left[\frac{480 \text{ min}}{480 \text{ min} - 63.1 \text{ min}} \right] - 1 \\
&= \left[\frac{480 \text{ min}}{416.9 \text{ min}} \right] - 1 = 1.151 - 1 = 0.151, \text{ or } 15.1\%
\end{aligned}$$

By including the fatigue time from Example 2, the A_{pfd} in Examples 1 and 2 are now equivalent.

7.6 Rest Allowances³

The International Labour Organization (ILO) recognizes that determining allowances is a controversial part of work study because it is difficult to develop an internationally accepted scheme of allowances to meet every working situation in the world despite extensive research by various organizations. ILO attributes the difficulty in establishing universal allowance guidelines due to the following factors:

1. Factors related to the individual, such as work ethic, learning curves, ethnic variations, and nourishment of the worker.
2. Factors related to the nature of the work itself, such as light vs. medium vs. heavy work, standing up or sitting, posture of the worker, whether force must be exerted by the worker, undue eye or mental strain, wearing protective clothing, gloves, or goggles, whether there is a risk of spoiling or damaging the product, and so on.
3. Factors related to the environment, such as heat, humidity, noise, dirt, vibration, lighting intensity, dust, wet conditions, seasonal conditions, and so on.

Although the ILO does not endorse an international standard for allowances, they recommend the following allowances in Table 7.1.

Table 7.1. ILO Recommended Allowances⁴

A. Constant allowances:

%

- | | |
|----------------------------------|---|
| 1. Personal allowance | 5 |
| 2. Basic fatigue allowance | 4 |

B. Variable allowances:

- | | |
|---|---|
| 1. Standing allowance | 2 |
| 2. Abnormal position allowance: | |
| a. Slightly awkward | 0 |
| b. Awkward (bending) | 2 |
| c. Very awkward (lying, stretching)..... | 7 |
| 3. Use of force, or muscular energy (lifting, pulling, or pushing): | |
| Weight lifted, lb: | |
| 5 | 0 |
| 10 | 1 |

15	2
20	3
25	4
30	5
35	7
40	9
45	11
50	13
60	17
70	22
4. Bad light:	
a. Slightly below recommended	0
b. Well below	2
c. Quite inadequate.....	5
5. Atmospheric conditions (heat and humidity) – variable	0-100
6. Close attention:	
a. Fairly fine work.....	0
b. Fine or exacting	2
c. Very fine or very exacting.....	5
7. Noise level:	
a. Continuous.....	0
b. Intermittent – loud	2
c. Intermittent – very loud.....	5
d. High-pitched – loud	5
8. Mental strain:	
a. Fairly complex process	1
b. Complex or wide span of attention	4
c. Very complex	8
9. Monotony:	
a. Low	0
b. Medium.....	1
c. High	4
10. Tediousness:	

a. Rather tedious	0
b. Tedious.....	2
c. Very tedious	5

7.7 Determining Percentages

P, F, and D percentages can be determined using any of the following techniques:

1. Historical time studies.
2. Work sampling.
3. Estimates based on experience.
4. Dictated by top management.

7.8 Applying P, F, and D Percentages

Percentages can be applied in any one of the following ways:

1. The entire plant receives one Apfd % (the most common practice).
2. Each department has its own Apfd %.
3. Each job has its own Apfd %.

Typical percentages used in industry range from 7.5% up to 20%. In general, most manufacturing companies use a P, F, and D percentage of 15%.

In the business and service sectors, the P, F, and D percentages range from 25% up to 100%. The most common percentage used by service organizations is 50%.

The final P, F, and D percentages are not shown to the exact values determined by time study, such as 13.2%. Instead, the final P, F, and D percentages are usually rounded up to the next 2.5%, such as 12.5%, 15%, 17.5%, 20% and so on.

7.9 Summary

Allowances for personal time, fatigue, and delays are crucial for establishing accurate and fair time standards in a production environment. These allowances ensure that the time standards reflect real-world working conditions, promote worker well-being, and lead to more efficient and effective production planning and productivity measurement. By incorporating these allowances, industrial engineers can ensure that the work pace is sustainable and that workers have enough time to address personal needs, recover from fatigue, and manage unavoidable delays.

References

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