The DLS methodology: answers to frequently asked questions (updated 29 September 2018)

As of October 1, 2014, the Duckworth/Lewis method has been updated from the Professional Edition to the Stern Edition, hereafter referred to as the Duckworth-Lewis-Stern (DLS) System. The following document gives basic discussion regarding various aspects of both the concepts and the implementation of this method for setting targets in shortened limited overs cricket matches.

Note that in all discussions the side batting first is called Team 1 and the side batting second is called Team 2.

1. **How can copies of the full tables be obtained?**
   The over-by-over tables for use with the D/L Standard Edition may be found on the ICC website (follow the Rules and Regulations link and click on *Duckworth/Lewis Standard Edition Table* for a pdf file.) The full tables are available to all cricket authorities.

2. **How can I get hold of the DLS or Professional Edition software?**
   Neither of these software programs is yet available for sale to the general public; when it is details will be available on the ICC website (www.icc-cricket.com)

3. **How can I obtain more detailed information on the D/L methodology?**
   There are two academic papers that explain the mathematics of the D/L methodology behind the Standard and Professional Editions.
   - *Duckworth, F. C. & Lewis, A. J. (1998). A fair method of resetting the target in interrupted one-day cricket matches. Journal of the Operational Research Society, Vol. 49, No. 3, pp. 220-227.*
   - *Duckworth, F. C. & Lewis, A. J. (2004). A successful Operational Research intervention in one-day cricket. Journal of the Operational Research Society, Vol. 55, No. 7, pp. 749-759.*

   Similarly, the details of the DLS method have been published in the academic paper:

   - *Stern, S. E. (2009). The Duckworth-Lewis-Stern method: extending the Duckworth-Lewis methodology to deal with modern scoring rates. Journal of the Operational Research Society, Vol. 67, No. 12, pp. 1469-1480.*

   Students may be able to obtain the papers from their campus libraries, or from other sources. Otherwise the papers can be obtained from the journal's publishers Palgrave Macmillan.

4. **What books are available giving some background and a general description of the method?**
   This booklet gives a very thorough understanding of the workings of the method. "*Your Comprehensive Guide to the D/L Method*…", which is available in electronic or hard-copy form from Acumen Books

   The book, "*Duckworth Lewis: The method and the men behind it"*, written by Frank Duckworth and Tony Lewis and published by SportsBooks gives the story of how the D/L methodology was developed up until their retirement in 2013. It also includes full tables for the D/L Standard Edition.

5. Where can I obtain details of the D/L methodology on line?

The ICC web-sites provide the best sources.

6. But why the DLS method? What was wrong with the old methods?

At the start of one-day cricket the Average Run Rate (ARR) method was used to set the target. For example, if Team 1 made 250 in their 50 overs, an ARR of 5 runs per over, and Team 2's innings was reduced to 25 overs, the score to beat was 5x25=125. Because Team 2 still had all 10 wickets this was a somewhat easier task than 250 in 50 overs and so, whenever rain was around, captains winning the toss usually chose to bat second to take advantage of this situation. For many years it was known to be unfair (and in several other ways too) but the method's simplicity, and the lack of any viable alternative, meant that ARR was used in most one-day matches until the early 1990s.

The Australians devised the 'Most Productive Overs' (MPO) method whereby Team 2's target for a reduced number of overs was based on the runs scored in the most productive of that many overs scored by Team 1. In other words, the target was reduced by the number of runs scored in the number of least productive overs equal to the number lost.

However, the rationale of this method was based on stoppages occurring during the interval, so that if Team 2 lost say 25 overs, then their target was derived from the 25 most productive overs in Team 1's innings, irrespective of when the overs were lost. So if the stoppage was in the latter part of Team 2's innings it often gave a grossly unfair target.

This deficiency was highlighted in the ICC Cricket World Cup 1992 semi-final in Sydney when South Africa were reduced from requiring 22 runs in 13 balls to 22 runs in one ball when two overs were lost. This arose because the two least productive overs of England's innings were in fact two maidens. A match with a very close outcome had been reduced to a certainty for England with much annoyance to players and spectators alike and much embarrassment to cricket's authorities. (See also Q27)

The D/L methodology was developed during the mid-1990s and was the first to take account of the state of the match when overs were lost, i.e. both the number of overs which had been bowled and the number of wickets that were down. It came into operation at the start of 1997.

However, as scoring rates in limited overs matches began to steadily increase, the 'one-size-fits-all' approach of the original version of the D/L methodology (now commonly referred to as the D/L Standard Edition) ceased to adequately deal with matches with high scoring rates. As a result, first the Professional Edition in 2004 and then the Stern Edition in 2014 were introduced to appropriately handle the increasing prevalence of high and very high scoring matches, respectively. The following sections provide more direct insight to the workings and rationales of the methodology in general and the DLS method in particular.

7. What is the basis of the D/L methodology?

Whereas the Average Run Rate method set the target in proportion to the overs available to the two teams, the D/L method adjusts the score in proportion to the run-scoring *resources* available to the two teams. These are a given number of overs and ten wickets. The measure of resources is based on what teams have in an uninterrupted ODI innings so the resources at the start of such an innings, that is 10

wickets and 50 overs, are designated as 100%. In matches that have fewer overs per side resources are still based on the 50-over match. For example in a 25-overs per side match teams have half the overs of an ODI but still have all 10 wickets and so have more than half the resources of a 50-over innings – our tables calculate it to be about 70%.

As teams receive overs and lose their wickets they consume their resources. If rain interrupts play then the loss of overs reduces the resources of the batting side according to overs left and wickets lost at the stoppage and their interaction. Overs left are not worth much unless wickets are available to use them. Conversely, having plenty of wickets in hand is of little value unless there are sufficient overs with which to use them. So the overs and wickets resources change in their value according the state of the innings.

The D/L methodology calculations take account of the combined resources available to the two teams and adjust the target accordingly – see Q29-32 for information on books and websites with more details of the process.

8. **Why should Team 2 sometimes be set the task of scoring *more* runs than were made by Team 1 when they have the same number of overs to face?**
When the interruption occurs during the first innings, so that the match is shortened to one of fewer overs per side than it was at its start, Team 1 are usually more disadvantaged than Team 2. Before the stoppage they had been pacing their innings in the expectation of receiving say 50 overs but would have taken more risks to score faster had they known their innings was to be shortened. Team 2, on the other hand, know from the start of their innings that they have the reduced number of overs and can pace their entire innings accordingly Team 2 are set a higher target to compensate Team 1 for this disadvantage.

Consider, for example, when Team 1 have batted for 40 of an intended 50-over innings and then rain washes out the rest of their innings and there is just time for Team 2 to receive 40 overs. If they had wickets in hand, Team 1 might have expected to make around 80 runs in those final 10 overs. But Team 2 know they have only 40 overs to receive from the moment they start their innings. The average score in a 40-over innings is only about 20 less than that made in 50 overs, so Team 1's loss is typically 60 runs greater than Team 2's. Hence the target is raised by this amount.

The necessity to set a higher target for Team 2 arises from the regulations for most competitions requiring lost overs, where possible, be divided equally between the two sides. It would be possible to compensate Team 1 for their disadvantage by allowing them to face more overs than Team 2 and in this way the latter need not be set an enhanced target, but this requires a more complicated calculation and, more importantly, would reduce the scope for accommodating further stoppages. Because of these disadvantages, cricket authorities have preferred to stay with the present regulations and accept enhanced targets where these arise.

9. **Why should this apply when Team 1 have been bowled out?**
In limited overs cricket no distinction is made between the two ways in which an innings is closed, using up all the overs or losing all ten wickets. In both cases the team have used up all the resources of their innings. In an uninterrupted innings, there is no difference between Team 1's score of 250, for instance, whether it were 250 for 3 wickets in 50 overs or whether it were 250 all out in 47 overs. Similarly in an interrupted innings, the method of target revision cannot and should not distinguish between whether Team 1's innings were terminated by being all out or by using up their allocation of overs.

10. But why should the target score sometimes go *down* if there is an interruption in the first innings and teams have the same number of overs?

When Team 1's innings is shortened it usually means that Team 1 were disadvantaged and so an enhanced target is set to neutralise this disadvantage. But it is possible that the loss of overs might in fact have advantaged them, as in the following situation.

Suppose Team 1 started well but the wheels fell off and they were 150/9 after 30 of their 50 overs. On average they would be all out shortly, leaving Team 2 to score at a rate of around 3 per over for their 50 overs. But if rain interrupted play at this point and 19 overs were lost per side, then on resumption Team 1 would have only one further over to survive and their run rate would then be close to 5 per over. By all the 'old' methods, for 31 overs also, Team 2 would have to score around 150, around 5 per over, to win – in other words Team 1 would have been greatly advantaged by the rain interruption changing a required scoring rate of 3 per over to 5 per over for Team 2. By the D/L methodology, Team 1's advantage is neutralised and the target for Team 2 would be well below 150 in this circumstance, and fairly so, which maintains the advantage Team 2 earned before the stoppage. In other words, quite logically, Team 2 have to get fewer runs to win than Team 1 scored in the same number of overs.

11. What is the difference between the D/L Standard Edition and the DLS method?

At the top level of the game, the DLS method is now used. This requires use of a computer program. At lower levels of the game, where use of a computer cannot always be guaranteed, the D/L Standard Edition is used. This is the method which was used universally before 2004; it is operated manually using the published tables of resource percentages.

In the D/L Standard Edition, enhanced targets are obtained by applying the excess resource that Team 2 have over Team 1 to the quantity G50, which is the average runs scored in an uninterrupted 50-over innings. As resources are measured in terms of a full 50-over innings, then the same value of G50 is used for all lengths of match, e.g. in 40 over/side and Twenty20 matches.

G50 is not used in the DLS method, which employs a different approach to calculating enhanced targets.

For a full description of the operation of the D/L Standard Edition go the ICC web-site and follow the Rules and Regulations link.

12. What is the difference between the DLS method and its predecessor, the Professional Edition?

As noted in Q2, the increased prevalence of very high scoring matches led to the need for the DLS method. The increased availability of data from very high scoring matches indicated that targets and par scores based on the Professional Edition began to deviate from observed scoring data when run rates became very high (typically above 350 in ODIs and above 180 in T20Is). The reason for this relates to the way in which the two approaches adjust for the effects of high scoring rates.

Both the DLS method and the Professional Edition recognise that as overall scoring rates increase, the degree to which run rate acceleration can be achieved later in the innings must be "damped". For example, the methods recognise that while a team which has scored at 4.8 runs/over for the first 30 overs may readily accelerate to achieve a final score of 300 (a 25% increase in overall scoring rate), the same is not true of a team which has scored at 7.2 runs/over for the first 30 overs (as a 25%

increase in overall scoring rate would result in a final score of 450, a very rare total in ODIs).

The Professional Edition undertakes damping of the acceleration for high scoring matches evenly across the innings. However, available data for very high scoring matches indicates that the damping in acceleration actually takes place more rapidly early in a 50-over innings and more slowly late in the innings. This is the damping pattern employed by the DLS method. In particular, this gives DLS method par score structures for very high scoring 50-over matches an "intuitive" look comprising three phases: a good start, followed by a period of consolidation, and then a highly accelerated finish; as opposed to the steady increase in run rate throughout the innings characteristic of Professional Edition par score patterns.

In general, the different damping pattern leads DLS method par scores for very high scoring to be higher early in ODI innings and lower later in the innings (indicating more extreme run rates are possible later in the innings, where acceleration damping is lower). For an example, see Q28. However, for moderate scoring, and even high scoring matches, the results from the DLS method and the Professional Edition are essentially identical.

13. Scoreboards show the par score for Team 2 when their innings is in progress – why don't you add one run to give Team 2's 'target' in the event of a match termination, so avoiding mistakes such as South Africa's in the ICC Cricket World Cup 2003?

Suppose Team 1 score 250 in 50 overs. What's the target for Team 2? It's 251, of course, and cricketers and spectators don't need this stated on the board, just the 250. If Team 1 restrict Team 2 to 249 in their 50 overs then everyone knows Team 1 have won – by 1 run. In other words 250 is the 'balance' of the match – it's what Team 2 have to beat and Team 1 have to keep Team 2 below.

Similarly, the par scores displayed on scoreboards, and given on a sheet to officials, team camps and media, represent the balance of the match. As the innings progresses Team 1 are trying to keep Team 2 below the par score by economical bowling and taking wickets, and Team 2 are trying to get ahead of it – in case the match is abandoned at that point. Adding one run to the par score displayed would distort the neutrality of that balance.

In that 2003 match South Africa did indeed mistake the par score for the score they needed to win – they thought the par of 229 at the end of the 45th over was enough to win on abandonment and having reached 229/6 in 44.5 overs spurned an opportunity off the 6th ball to go for an extra run and the match was tied. But it was a misreading of the sheet – which clearly stated "if match abandoned par score shown in table below is that needed to TIE".

Whereas the furore has been over the South African camp's mistake and their resulting elimination from the competition, the Sri Lankan captain Sanath Jayasuriya read the same table correctly and knew the result was a tie when the match was abandoned.

14. Why don't you take away wickets as well as overs to even things up?

This is a simple idea but it would create many difficulties in implementation. First is how to apportion wickets deducted for overs lost bearing in mind not only the rate of deduction (which might result in a fraction of a wicket!), but also the fact that earlier wickets are more valuable than later wickets. Second is the problem of deciding which batsmen shall not be allowed to bat. This could cause dissatisfaction not only to the batsmen excluded but also to spectators who may have come to see particular players bat. Because of such problems cricketing authorities have regarded the idea of deducting wickets as an unacceptable option.

15. When Team 2's innings is interrupted, why do you not set a target that maintains the *probability* of achieving the target across the stoppage?

The problem with maintaining Team 2's probability of achieving their target across a stoppage is that it would mean that the target depended upon how many runs they had scored at the point of interruption. The more runs they had scored the more they would need, and the less they had scored the less they would need.

For instance, suppose that in three parallel matches, Team 1 score 250 in their 50 overs and Team 2's innings is interrupted after 20 overs with 10 overs lost in each case but with the scores at 60/2, 100/2 and 140/2. In all three cases the resources remaining were reduced from 68.4% to 54.4%, a loss of 14%, and so the target would be reduced by 14% of 250 to 216. If one set the revised target by scaling the runs still required by the resources remaining after and before the stoppage, which would maintain an equal probability of achieving the target, the targets would be different in the three cases, at 212, 220 and 228, respectively. It is surely unjust for a team to have to face a higher target because they had scored more runs. And an absurdity in the comparative results would be quite possible. Suppose, for instance, that the final scores of Team 2 in the three matches above are respectively 216, 220 and 226. The team scoring the most (226) would have lost the match and the team scoring the least (216) would have won.

The perceived problem with the way the revised target is set only arises when Team 2 are well ahead, or well behind, their par score. For instance, if they were 30 runs behind par at a stoppage and afterwards there was only time for a very few overs, they would still be 30 runs behind par and would have these few overs to make up the deficit, so their task may become virtually impossible. (If the match were washed out completely, they would have lost by 30 runs; nobody would dispute this.) It is Team 2's obligation to remain close to par to avoid losing if the match were terminated or their task being made more difficult if the innings were to be shortened.

16. How can Team 2 win by a number of runs; normally it's by wickets?

When Team 2's innings is prematurely terminated, the result is decided by comparing their actual score with their par score. Whether Team 2 have won or lost, the difference of their score from the par score is the best measure available of the margin of victory and so it has been decided that the result should be given in terms of this margin in all such cases.

Even in games which are not prematurely terminated, it is still possible to describe a victory for Team 2 in terms of a margin of runs. When they hit the winning run their score will be ahead of par by a certain margin and there is a good case for expressing the result in terms of this margin of runs. For instance, if Team 2 score the winning run off the last ball available, describing their victory in terms of their wickets in hand gives no indication of its narrowness.

17. How do we know whether to use the DLS method or the D/L Standard Edition?

The decision on which edition should be used is for the cricket authority which runs the particular competition. The DLS method can only be operated by running the appropriate computer software.

Playing conditions for ODIs and for most countries' national competitions require that the DLS method is used where a computer can be guaranteed to be available for all matches; otherwise, or in the unlikely event of the computer failing to be available and operable, the D/L Standard Edition is used.

Some club competitions use the D/L Standard Edition and some the DLS method depending on their opportunity to obtain the DLS software through their country's cricket administration.

18. Is the method good at predicting the results of one-day matches?

We must stress that the DLS method does ***not*** attempt to predict the result at a stoppage. It adjusts the target according to resources available at the time of the interruption and resources lost from it. Whatever happens in a match after that is irrelevant to the target setting process. As is commonly stated, cricket is a gloriously uncertain game and much can, and does, happen to change fortunes in a match – if the weather permits it to continue.

For example in the U19 World Cup on 19th August 2012 South Africa scored 244 in their 50 overs. After 27 overs England were progressing smoothly at 102/1 and were 12 runs ahead of par (based on the Professional Edition in use at the time). Rain threatened and had they gone off the field at that point never to return then England would have won – by 12 runs; they were in the stronger position and based on what has happened on average that result would have fairly reflected that position. However, rain didn't arrive and soon afterwards England slumped to 141 all out in 40.3 overs and lost by 103 runs. Here then was an example of the 'glorious uncertainty' of the game. The D/L methodology did not make a wrong 'prediction' at the possible termination; it would have been the weather, not D/L that had denied South Africa the chance of turning the match around had it been terminated by rain.

19. Is there any bias towards one team or the other in the usage of the method?

First let us look at uninterrupted ODI matches. Over the last decade or so, the proportion of uninterrupted ODIs won by Team 2 has steadily increased (perhaps as a result of Twenty20 batting experience teaching international batsmen how to accelerate more rapidly in a chasing situation at the end of an innings) from about 50% to about 54%.

From time to time we look at the overall performance of the D/L methodology. Although in a particular match bias cannot be determined, in the long run if there were any bias then the distribution of wins in matches where the D/L methodology has been used would be significantly different from the corresponding ratio in uninterrupted matches. In general, the ratio of Team 1 to Team 2 wins in 50-over matches decided by the D/L methodology at all levels of the game is not statistically significantly different from that in uninterrupted matches. In other words there is no evidence of bias to either side in interrupted matches by using the D/L methodology. At international level, there are generally not enough ODIs decided by the D/L methodology to make a statistically reliable comparison. However, despite this caveat, the data do exhibit the similar trend of an increasing proportion of Team2 victories seen in uninterrupted ODIs. In fact, this trend in D/L decided matches was one of the many reasons which prompted the investigation that led to the development of the DLS method.

By contrast, in T20I matches, the proportion of Team 2 wins in uninterrupted matches (which is the vast majority, as less 5% of T20Is are decided using the D/L methodology) has been on the order of 51% or 52%. As noted, it is hard to make a reliable statistical comparison with D/L decided matches, as there are so few of them; however, in the last decade of those matches which were decided by the D/L methodology, exactly half were won by Team 2.

Given all of this, it seems reasonable to conclude that there is no evidence to suggest that the D/L methodology is notably biased towards either the chasing team or the defending team.

20. How often is the method revised?

Playing conditions are continually changing and it is necessary to ensure that the method is keeping abreast of such changes. The parameters of the formula are reviewed every year and changes are made when shifts in scoring trends are seen to be significant. On average this occurs every two to three years.

21. Can the method be used for Twenty20 matches? There's a strong feeling that a separate formula is needed.

Many commentators and players believed that the D/L methodology was biased towards Team 2 in T20 games. Is there any evidence for this perceived bias? As noted below in Q19 there is no significant evidence that the D/L methodology favours one team or the other. Furthermore, detailed analysis of over-by-over run rates confirms that the scoring patterns in T20Is are statistically indistinguishable from those in the last 20 overs of an ODI. Thus, there is no need for a separate formula for Twenty20 matches.

22. Does the method take account of the higher scoring rates in the *PowerPlay* overs?

The purpose of the *PowerPlay* overs is to encourage attacking batting. But in addition it forces attacking field placing, so whereas runs do tend to be scored faster there is a corresponding increase in the wickets lost. The statistics collected over many years show that the runs scored per *resources* consumed in the PowerPlay overs are closely consistent with the same measure in the non-PowerPlay overs. We have therefore concluded that the D/L method does not need separate allowance for the PowerPlay overs. This conclusion has been found to be true for all the various forms of fielding restrictions from the 15-over rule to the present PowerPlay regulations. In practice, this is a fortunate conclusion as it would be extremely inconvenient for scorers to have to enter details of the number of PowerPlay overs that have already been bowled at a stoppage.

23. What would have been the situation under the DLS method in the ICC Cricket World Cup 1992 semi-final match between England and South Africa in Sydney?

Using the current DLS method, South Africa would have needed three runs to win from that final ball – an eminently achievable and fair target.