The Accidents Sub-Objective

TAG Unit 3.4.1

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Department for Transport

Transport Analysis Guidance (TAG)

Contents

1 The Accidents Sub-Objective

1.1 Introduction

1.1.1 This Transport Analysis Guidance (TAG) Unit provides guidance on appraising transport interventions against the Government's accident sub-objective.

1.1.2 Transport interventions may alter the risk of individuals being killed or injured as a result of accidents through a variety of means. Accident impacts occur across all modes of transport and affect non-users as well as users. This Unit provides a framework for appraising all transport interventions against the accident sub-objective, and the methods outlined below should be closely followed.

1.1.3 The latest Department for Transport (DfT) values for prevention of casualties and accidents are given below, together with an explanation of the basis upon which these estimates are made. These values are based on 2009 road accident data, and are given for 2009 at June 2009 market prices and values.

1.1.4 Appropriate caution must be taken when using values for the prevention of casualties to place a monetary value on accident-related impacts. These estimates are derived primarily for use in the appraisal of road schemes and must be carefully applied in other contexts. Further advice relating to the proper application of values for the prevention of casualties may be sought from DfT.

1.2 Overview of Accident Impacts

1.2.1 Transport accidents impose a range of impacts on people and organisations, including:

- pain, grief and suffering*;
- lost economic output*;
- medical and healthcare costs*;
- material damage^;
- police costs^;
- insurance administration^; and
- legal and court costs^.

1.2.2 Those impacts marked (^) are closely related to the number of accidents, while those marked (*) are related to the number of casualties. Therefore, numbers of accidents and numbers of casualties form the key quantitative indicators for the appraisal of transport interventions. Combining these numbers with values for the prevention of casualties and accidents yields a monetary estimate of the accident-related costs or benefits of proposed transport interventions.

1.2.3 The impact of **casualties** differs according to the severity of the injuries sustained. Three groups are usually differentiated; these are defined in the following way:

- Fatality: any death that occurs within 30 days from causes arising out of the accident;

- Serious injury: records casualties who require hospital treatment and have lasting injuries, but who do not die within the recording period for a fatality; and

- Slight injury: where casualties have injuries that do not require hospital treatment, or, if they do, the effects of the injuries quickly subside.

1.2.4 More detailed information on the classification of particular types of injury can be found in **Hopkin and Simpson**, 1995. Estimates of the value for the prevention of a casualty of each severity level are set out in Table 1, below.

1.2.5 The impact of **accidents** also varies according to severity. Values for the prevention of road accidents are presented in Tables 3 and 4.

1.2.6 Standard processes exist for forecasting changes in the numbers of accidents and casualties that will result from transport interventions, and estimating the associated impacts. Section 3.1 explains the approach that should be followed when appraising changes in the number of road accidents, and sections 3.2 – 3.5 describe the methods that should be followed in relation to other modes of transport.

2 Benefits to Society Arising from Prevention of Road Accidents and Casualties

2.1 Casualties

2.1.1 Since 1993, the valuation of both fatal and non-fatal casualties has been based on a consistent willingness to pay (WTP) approach. This approach encompasses all aspects of the valuation of casualties including the human costs and the direct economic costs. That is to say the Department's values for preventing casualties include an amount to reflect pain, grief and suffering, as well as the lost output and medical costs associated with road accident injuries.

2.1.2 The methodology used for valuing non-fatal casualties was described in an article in **Road Accidents Great Britain** (RAGB) 1992, and a further article in RAGB 1994 gives updated information. More detailed descriptions of methods and the underlying research have been published by the Transport Research Laboratory. In particular, a summary account of the full methodology has been published (Hopkin and Simpson, 1995). Full references are given at the end of this Unit.

2.1.3 RAGB 1997 contained an article describing the results of more recent research into the value of prevention of a road accident fatality. This utilised a Stated Preference method to estimate the values for the prevention of road casualties by eliciting information on how much a representative sample of the population would be willing to pay for various improvements in levels of safety. The research showed that a figure in the range £750,000 to £1,250,000 in 1997 prices could be regarded as being broadly acceptable. The mid-point of this range forms the basis for the Department's value for the prevention of a fatality. A similar approach has been used to derive the values for serious and slight casualties, which are pegged to the fatal value.

2.1.4 The 1997 mid-point value of £1m for the prevention of a fatality includes losses to society as well as losses that are borne by the victims themselves, their friends and relatives. Losses to society arise because medical and ambulance costs are largely met by the NHS, and because fatal injuries result in net economic output being lost (the difference between the present value of lifetime output and consumption).

2.1.5 The values for prevention of casualties, adjusted to reflect 2009 prices, by severity of casualty and by class of road user, are set out in Tables 1 and 2 respectively.

Table 1: Average value of prevention per casualty by severity and element of cost				
2009				£ June 2009
Injury severity	Lost output	Human costs	Medical and ambulance	TOTAL
Fatal	545,040	1,039,530	940	1,585,510
Serious	21,000	144,450	12,720	178,160
Slight	2,220	10,570	940	13,740
Average, all casualties	9,740	35,740	2,250	47,470

Table 2: Average value of prevention per road casualty by class of road user[1]	
2009	£ June 2009
Pedestrian	76,880
Pedal cyclist	48,430
Bus and coach occupants	26,490
Goods vehicle occupants	40,890
Car and taxi occupants	36,870
Motorised two-wheeler rider and passengers	91,880
All motor vehicle users	43,270
Average, all road users	47,740

[1] Note that the variation in value between classes of road user is due to differences in proportions of fatal, serious and slight casualties among each class of road user.

2.1.6 The values for the prevention of fatal, serious and slight casualties, given in Table 1, include the following elements of cost:

- human costs, based on WTP values, representing pain, grief and suffering to the casualty, relatives and friends, and, for fatal casualties, the intrinsic loss of enjoyment of life, excepting consumption of goods and services.

- loss of output due to injury. This is calculated as the present value of the expected loss of earnings plus any non-wage payments (national insurance contributions, etc.) paid by the employer. This includes the present value of consumption of goods and services that is lost as a result of injury accidents.

- ambulance costs and the costs of hospital treatment.

2.2 Accidents

2.2.1 The value of prevention of an injury accident may be greater or less than the value of the corresponding casualty i.e. the value of preventing a fatal accident might be more or less than the value of a fatality. This is for two reasons, the first being that an injury accident is classified according to the most severe casualty but on average may involve more or less than one casualty. The second reason is that there are some costs which are part of the valuation of an injury accident but which are not specific to casualties. These are:

- costs of damage to vehicles and property; and
- costs of police and the administrative costs of accident insurance.

Details of the derivation of these costs are available in a published Transport Research Laboratory Report (Simpson and O'Reilly, 1994).

2.2.2 For injury accidents occurring on the road, the value of prevention is **greater** than the value of prevention of the corresponding casualty. This is because in 2009, a fatal road accident on average involved 1.08 fatalities, 0.33 serious casualties and 0.48 slight casualties. In addition road accidents resulted in damage to vehicles and property, as well as incurring costs to the emergency services and car insurers.

2.2.3 Elements of the value of prevention of road accidents can be classified according to whether they relate specifically to casualties or to accidents. Casualty related values include lost output, medical and ambulance costs, and human costs. The costs of police, insurance and property damage are grouped separately as accident related values. The total value of prevention of an accident is the aggregate of both sets of values. Table 3 shows the total value of road accidents of different severities according to element of cost. However, since not all elements of accident values are quantified, the values presented below may be regarded as minimum estimates. For instance, the total road accident values do not include the costs of delays to other road users following accidents.

Table 3: **Average value of prevention of road accidents by severity and element of cost**

2009			**Cost Element**				**£ June 2009**
	Casualty related costs			**Accident related costs**			
Accident severity	**Lost output**	**Medical and ambulance**	**Human costs**	**Police cost**	**Insurance and admin**	**Damage to property**	**TOTAL**
Fatal	596,674	5,615	1,175,101	1,848	291	10,674	1,790,203
Serious	23,767	14,244	161,713	245	181	4,907	205,056
Slight	2,959	1,253	14,090	57	110	2,903	21,372
All injury	13,225	3,055	48,546	105	122	3,270	68,323
Damage only	-	-	-	3	52	1,828	1,883

2.2.4 Table 4a provides average values of prevention of road accidents by road type and Tables 4b and 4c give this information for daylight hours and darkness respectively. Prior to 2002 information on built-up and non-built up classes of road was given under the headings of urban and rural road, but the values are derived on exactly the same basis, using speed limits as the criterion. This terminology is consistent with the **Reported Road Casualties Great Britain** publication. Urban roads are now defined as major or minor roads within an urban area with a population of 10,000 or more, based on the 1991 Office of the Deputy Prime Minister definition of urban settlements. Rural roads are major and minor roads outside urban areas. If values are required for urban and rural roads rather than built-up and non built-up they can be supplied by DfT on request.

2.2.5 The average values for prevention of road accidents vary between built-up and non built-up roads and motorways because the average number of casualties per injury accident differs between categories of road (see Tables 4a, 4b and 4c). In addition, the cost of vehicle damage per accident varies by road category. For example, a serious accident on a non-built up road will on average involve 1.16 serious casualties, compared with 1.06 serious casualties on a built-up road, together with a greater amount of vehicle damage.

Table 4a: **Average value of prevention per road accident by severity and class of road: all hours**

2009				**£ June 2009**
	Road Class			
Accident severity	**Built-up[1]**	**Non Built-up[2]**	**Motorway**	**All**
Fatal	1,730,851	1,826,109	1,952,832	1,790,203
Serious	196,589	221,092	234,008	205,056
Slight	20,245	23,988	28,497	21,372
All injury	55,076	109,151	82,681	68,323
Damage only	1,770	2,617	2,517	1,883
Average cost per injury accident including an allowance for damage on accidents	86,402	129,561	101,808	96,706
[1] Built-up roads are those roads other than motorways with speed limits of 40pmh or less				
[2] Non Built-up roads are those roads other than motorways with speed limits greater than 40mph				

Table 4b: **Average value of prevention per road accident by severity and class of road: daylight hours**

2009				**£ June 2009**
	Road Class			
Accident severity	**Built-up[1]**	**Non Built-up[2]**	**Motorway**	**All**
Fatal	1,683,648	1,817,145	1,903,038	1,765,214
Serious	193,902	220,879	232,844	203,266
Slight	20,075	23,956	28,618	21,218
All injury	49,384	101,392	70,357	61,726
Damage only	1,770	2,617	2,517	1,881
Average cost per injury accident including an allowance for damage on accidents	80,710	121,802	89,484	90,158

[1] Built-up roads are those roads other than motorways with speed limits of 40pmh or less
[2] Non Built-up roads are those roads other than motorways with speed limits greater than 40mph

Table 4c: **Average value of prevention per road accident by severity and class of road: hours of darkness**				
2009				**£ June 2009**
		Road Class		
Accident severity	**Built-up[1]**	**Non Built-up[2]**	**Motorway**	**All**
Fatal	1,785,409	1,840,861	2,000,908	1,824,162
Serious	202,500	221,615	236,067	209,096
Slight	20,738	24,071	28,201	21,807
All injury	70,866	129,320	111,497	86,227
Damage only	1,718	2,564	2,465	1,837
Average cost per injury accident including an allowance for damage on accidents	101,269	149,323	130,228	113,696
[1] Built-up roads are those roads other than motorways with speed limits of 40pmh or less				
[2] Non Built-up roads are those roads other than motorways with speed limits greater than 40mph				

2.3 Uprating of values

2.3.1 For 2009, the values for prevention of road accidents and casualties have been adjusted using an index which reflects observed inflation and real per capita economic growth in the period from June 1997 to June 2009.

2.3.2 If values are required at June 2010 price and output levels, these can be calculated by adjusting the June 2009 values provided in the tables in this Unit by the current estimate of the increase in nominal GDP per capita between 2009Q2 and 2010Q2, which may be obtained from the Office for National Statistics. Therefore 2009 values can be obtained by multiplying the values in this Unit by a factor equal to:

$$1 + \frac{\%\,\text{increase in nominal GDP per capita}}{100}$$

2.3.3 The appropriate price base year for all NATA appraisals is 2002. The value of preventing accidents in future years can be estimated in 2002 prices by increasing the 2002 values provided in Annex A of this Unit by the expected long term real GDP per capita growth rate. This is on the assumption that the real cost of each element of accident costs (such as the cost of medical treatment) will rise in line with increases in output. Forecast growth rates in real GDP per capita are provided in Table 3 of TAG Unit 3.5.6 **'Values of Time and Operating Costs'**.

3 Use of Accident and Casualty Values for Appraisal

This section provides guidance on how to appraise the impact that transport interventions have on accidents and casualties.

3.1 Application of TAG to Highway Schemes

3.1.1 The impact of changes in the number and severity of road accidents constitutes an important element of the appraisal of road transport interventions, which can generate significant accident reduction benefits if designed well. To appraise road accident impacts, a forecast of the numbers of road accidents of different severities must be produced for both 'with' and 'without' intervention scenarios. An estimate of the monetary value of the difference in accident numbers and severities between the two scenarios must then be calculated to aid comparison with the other impacts, such as scheme costs.

3.1.2 Estimates of the difference in the number of injury accidents, and casualties by severity, over the appraisal period must be reported in the quantitative entry of the Appraisal Summary Table (AST). In addition, the monetised present value of accident reduction benefits – in 2002 market prices – must be clearly presented in the assessment entry of the AST. Any other factors of significance should be noted in the qualitative entry of the AST.

3.1.3 This process of road accident appraisal should be carried out in a manner that is proportionate to the cost of the intervention and the scale of its impacts. The appropriate level of detail to adopt will also depend on the availability of information on accident impacts.

Major Highway Schemes

3.1.4 The accident impact of major road transport interventions should be appraised using the methods set out in the COBA Manual (DfT). These are embodied in the COBA computer program, which may be used to forecast changes in the numbers of accidents and casualties, and estimate the monetary value of these impacts. The COBA software uses values for prevention of casualties that are derived on the same basis as described in this Unit but differ in three respects:

i) COBA values are expressed in a 2002 price base, rather than the 2009 price base here;

ii) In COBA, severity splits are averaged over three to five years;

iii) COBA uses a finer disaggregation of road categories and also details junctions separately.

3.1.5 For the purposes of appraisal it is necessary to form a view on how costs will vary over future years. Most elements of the values of prevention of road accidents and casualties are proportional to average income, so they are assumed to increase in line with real GDP per head with an elasticity of unity. Forecasts of GDP per head are provided in Table 3 of TAG Unit 3.5.6 '**Values of Time and Operating Costs**'.

3.1.6 The techniques used by COBA to estimate the change in the number of accidents of different degrees of severity are based on established parameters for the number of accidents per million vehicle-kilometres on different types of road. As the number of vehicle-kms on the network change as a result of the introduction of an intervention, so the number of accidents will also alter. Thus, if the impact of an intervention is to reduce the number of vehicle-kms travelled, then this will tend to reduce the number of accidents on the network. Similarly, if the intervention causes a reduction in the number of vehicle-kms on one type of road but an increase for a second type of road, then the net impact on the number of accidents will depend upon the relative accident rates for the two types of road.

3.1.7 COBA calculates the total cost of accidents on a road network by multiplying the number of accidents predicted to occur by a value of prevention of an accident, which varies by type and area of road. The number of accidents on a given length of road is expressed as an accident rate, defined as so many 'Personal Injury Accidents per million vehicle kilometres', so that doubling either the length or the traffic flow on the road will double the number of accidents. Apart from length and flow level, in COBA there are two determinants of the number of accidents: the number and type of junctions and the type of links.

3.1.8 COBA incorporates a method of separating the effects of links and junctions on accidents. Where junctions are coded for delay calculation, these should be coded for accident calculation. In addition, where there are junctions which are subsumed in links for speed calculations (in particular in urban areas), but which are likely to be associated with accidents, these should be coded as 'accident-only' nodes. Finally, where either a very large link-only network is used and 'accident-only' nodes are difficult to identify, or local data on existing accidents are difficult to split between links and junctions, combined 'link and junction' accident rates can be attributed to links. The treatment of accidents on links and junctions is described in greater detail in Part 2 of the COBA Manual.

3.1.9 Overall accident costs are determined using details of the average accident severity split (that is, the number of fatal, serious and slight casualties per accident) and the proportion of fatal/serious/slight accidents. To forecast the average proportions of fatal and serious accidents on links and junctions, COBA uses 1999-2001 data (see COBA Manual, Tables 3/2 and Table 3/3) that is adjusted using 'accident rate change coefficients' (COBA Manual, Table 4/1) in order to account for trend reductions in the rate and severity of accidents over time. The proportion of slight accidents is then calculated by subtracting the sum of the fatal and serious proportions from unity. Accidents are classified according to the most seriously injured casualty and for accident coding purposes 'rural' roads are defined as those with a speed limit of more than 40 mph (64 kph). Those with speed limits of 40 mph or below are defined as 'urban' roads.

3.1.10 The average accident costs used in COBA will normally be appropriate even where local accident rates differ from the average. In some circumstances the severity split may differ, with a consequent change in average accident costs, but this is only likely to be significant in a few cases. The use of local severity splits is discouraged and the DfT must be consulted if their use is considered necessary. In such cases the user must:

i) Demonstrate that the severity split is significantly different in statistical terms from the COBA value, and also that this does not result from one or two particularly bad accidents, the effect of which will be evened out by less extreme accidents as time goes by. Data covering all available accident history, with a minimum of five years must be supplied.

ii) Arrange an Accident Investigation and Prevention Study by the Local Authority to identify the causes of the safety problem and recommend remedial safety measures. Where this study concludes that modest remedial works are unlikely to correct the problem then there may be a case for using a local severity split. However where modest remedial works are recommended, the cost of these works should be included in the without intervention scenario and the revised COBA severity split used.

3.1.11 The values for preventing road accidents applied by COBA include an allowance for damage only accidents. Statistics on damage only accidents are not generally available – because they are not comprehensively reported to the police – so instead survey information is used to estimate the occurrence of damage only accidents. COBA assumes that damage only accidents occur at a rate of 17.7 per personal injury accident in urban roads, 7.8 in rural roads and 7.6 on motorways, and that these rates remain constant over time.

3.1.12 TUBA software does not include calculation of the monetised Present Value of Benefits (PVB) of accident reductions. The COBA program may be used to obtain the PVB for traffic forecasts using both fixed and variable trip matrices.

3.1.13 QUADRO may be used to perform calculations for accidents during construction and accidents during maintenance.

Smaller Highway Schemes

3.1.14 Accident impacts of road transport interventions should be appraised using an approach similar to that taken by COBA. The difference between the number and severity of road accidents and casualties, in with and without intervention scenarios should be forecast. The monetary value of this impact can then be estimated by applying the appropriate values for prevention of road accidents or casualties from Tables 1 to 4 of this Unit.

3.1.15 Where large numbers of fatal, serious and slight accidents are known for the part of the network under consideration, then these may provide a reliable guide to the proportion of casualties of different severity to be expected in future. In such circumstances the average values for prevention of accidents of each severity can be applied (see Table 3). Typically however, there is only data for a small number of accidents on the part of the network which is being considered. Therefore, the observed severity mix cannot be expected to provide a reliable guide to the future severity mix. In such cases, or where no breakdown by severity is available and only the total number of injury accidents is known, the average values for all injury accidents should be used to estimate a value of those road accidents. This is equivalent to assuming the national proportions of different accident severities.

3.1.16 A similar method should be employed for valuation of casualties using the average values by severity of casualty or by class of road user that are provided in Tables 1 and 2. It should be noted that the variation in the values for different classes of road user is due to different proportions of each class suffering fatal, serious or slight injuries when involved in a road accident. There may be some over-estimation of average values of prevention per accident and per casualty due to under-reporting of less-severe accidents. Variations between road user categories in the extent of under-reporting of less severe casualties would affect comparison of average values per casualty by class of road user.

3.1.17 In addition to values for prevention of injury accidents, estimates are provided for damage-only accidents. Since damage-only accidents are not comprehensively reported to the police, reliable information on their number may not be available. In these circumstances an estimate can be made of the value of prevention of accidents (including damage-only accidents) using an average accident value per injury accident (as in Tables 4a, 4b and 4c). These values include an allowance for damage-only accidents, which is calculated assuming the same rates of damage-only accidents as COBA (see paragraph 3.1.11).

3.1.18 The values for prevention of road accidents and casualties which are given in this Unit will vary over future years as a result of changes in the value of lost output, medical costs and willingness to pay for reductions in risk of injury. Each element will change in proportion to average income, so the values for prevention of road accidents and casualties should be uplifted in line with forecast growth in real GDP per head (Table 5) when accident impacts are predicted to occur in future. For example the benefit of an intervention that prevents a fatal accident in 2010 can be estimated by increasing the value for prevention of a fatal accident by forecast GDP growth per capita between 2009 and 2010 (set out in Unit 3.5.6, **Values of Time and Operating Costs**).

3.2 Application of TAG to Rail Interventions

3.2.1 Railway duty holders are legally required to ensure health and safety on the railways as far as is reasonably practicable. They undertake a process of risk assessment in order to meet this obligation. Cost benefit analysis provides an important tool in support of decisions over whether to proceed with interventions that could reduce the risk of accidents occurring. Guidance [intended for internal audience] on the use of cost-benefit analysis techniques in support of safety-related investment decisions is provided by the Office for Rail Regulation (ORR, 2008a): **Internal guidance on cost benefit analysis (CBA) in support of safety-related investment decisions**. This recommends that the DfT's value for prevention of a fatality, the latest estimate of which is presented in Table 1 above, should be used to estimate a monetary value of casualty reduction benefits. Comparing these benefits with the costs of the intervention can then provide a guide to whether the costs of implementing it would be grossly disproportionate to the expected benefits. Incremental analysis of the health and safety related costs and benefits of measures that are in addition to business as usual appropriate for determining whether it is reasonably practicable to approve a measure.

3.2.2 More general explanation of context of duty to uphold health and safety is provided by the Office for Rail Regulation in **Internal guidance and general principles for assessing whether health and safety risks on Britain's railways have been reduced so far is as reasonably practicable**.

Table 5: Rail injury classification, weights and values

Injury	Description	Weight	Average value, £ June 09
Fatality	Fatality within one year of the causal accident	1	1,585,510
Major injury	An injury as defined in schedule 1 of RIDDOR 1995, or where the injury resulted in hospital attendance for more than 24 hours	0.1	158,551
Reportable minor injury	For workforce, any injury resulting in more than 3 days off work, which is not a major injury. For passengers and members of the public, any injury that leads to a person being taken from the site of the accident to hospital for treatment, which is not a major injury	0.005	7,928
Non-reportable minor injury	Any other physical injury that is not a fatality, major or reportable minor injury	0.001	1,586
Class 1 shock/trauma injury	Shock/trauma injuries due to witnessing all fatal incidents, attempted suicides, passengers struck by trains, train accidents (except 'Collision of train with object on line (not resulting in derailment)')	0.005	7,928
Class 2 shock/trauma injury	Shock/trauma injuries due to physical and verbal assaults, witnessing non-fatal incidents of near misses, assaults, trespasser and workers struck by train, and all other miscellaneous events	0.001	1,586

3.2.3 GB mainline railway guidance, **Taking Safe Decisions** (RSSB,2008), sets out common principles upon which decisions concerning safety on the railways may be based and gives details on factors that should be taken into account in decisions. It refers to use of DfT's estimate of the value for prevention of a fatality in attaching a social value to risk of injury. When considering accident risks, rail appraisals take into account the expected numbers of major and minor injuries which are expected to occur and weight these relative to fatalities (currently 0.1 of a fatality for a major injury and 0.005 for a minor injury – see table 5). The lower weighting of rail accident minor injury risk is because these injuries are generally less severe than the road accident slight injury risk. For example, the road accident slight injury risk contains a high proportion of whiplash injuries, which can be quite severe in nature, and are not present to the same extent in the rail accident minor injuries. Note that these figures do not include any allowance for damage costs as they can vary too widely for similar casualties – these costs should be addressed by bespoke calculations elsewhere. For further information see RSSB 2008, The weighting of non-fatal injuries, **T440 Fatalities and Weighted Injuries** and The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 (RIDDOR).

3.3 Application of TAG to Major Public Transport Schemes

3.3.1 Appraisals of major schemes in Local Transport Plans must consider accident benefits or disbenefits in full. Differences in the number and severity of accidents that are predicted to occur over the appraisal period must be properly justified, and the impacts should be transparently calculated drawing upon the methodology set out in this Unit as appropriate. The Department's COBA software may be used where highway schemes are being considered. The results should be clearly reported in qualitative, quantitative and present value monetary terms in the appropriate columns of the AST.

3.3.2 Information on the appraisal of schemes within Local Transport Plans can be found in **Detailed Guidance on Major Scheme Appraisal in Local Transport Plans** (Tag Unit 3.9).

3.4 Application of TAG to Aviation and Maritime Interventions

Air Transport

3.4.1 Interventions that effect air transport modes may have wide-ranging accident impacts. For instance the risk of individuals being killed or suffering injuries of different severities may alter as a result of changes in the operation of air terminals, or different patterns of ground movements by airport users (both within airports and on associated surface access routes), or as a result of aeroplane arrivals and departures.

3.4.2 The magnitude of the impact on accident risks will depend in part on passenger volumes and on the standard of the infrastructure in question. Where possible, these risks should be quantified and expressed as differences in the number of persons who are expected to be injured between the 'with' and 'without' development scenarios. The equivalent monetary value of these impacts should also be estimated using the values for prevention of casualties presented in Table 1 if sufficient data is available. However some elements of the values for prevention of casualties, particularly lost output and medical and ambulance costs, are likely to differ from those given in Table 1 due to differences in injury types and the context which they are sustained. Therefore the estimated value of the accident impact will subject to a degree of uncertainty and should be subjected to sensitivity analysis in order to test a range of assumptions around the value of preventing air transport casualties.

3.4.3 The values for prevention of road accidents presented in Tables 3 and 4, above, should not normally be applied when appraising the accident impact of aviation developments. This is because each of the elements that comprise the value of aviation accidents could differ from those presented above for road accidents. This might arise because of differences in the number of people involved in road and aviation accidents or the degree of damage these cause to property.

Maritime Interventions

3.4.4 There are a number of different, but related, aspects of maritime safety which should be appraised. These include safety of dockworkers and others working in dock areas, safety of seafarers and passengers, safety of those living and working in the vicinity of ports, safety of maritime leisure users, the safety of ships and their cargoes, and changes in safety resulting from maritime search and rescue schemes. Safety on the surface access system that serves a port development by carrying cargo, passengers and employees should also be taken into account when appraising maritime proposals. Where appropriate accidents on surface access modes may be assessed using the methods detailed above.

3.4.5 There is no definitive method for the monetary valuation of safety impacts of maritime interventions. In the absence of other evidence the values set out in Table 1 should be used in the appraisal of any maritime intervention to provide a reference point that reflects the benefits of preventing injuries and fatalities. The results which are obtained should then be subjected to sensitivity analysis.

3.4.6 The costs of accidents caused by maritime interventions could be considerably different to other modes given the nature of sea transport (where the size of vessel relative to number of occupants and the likely environmental and supply chain consequences of accidents differ from other modes) so the values for preventing road accidents set out in Table 3 should not normally be applied.

3.4.7 Additional information on the appraisal of port accident impacts is provided by **A Project Appraisal Framework for Ports** (DfT, 2002).

3.5 Application of TAG to Walking and Cycling Schemes

3.5.1 Appraisals of interventions that primarily affect the conditions of cyclists and walkers, such as the development of a cycle route or footpath, should include quantified and monetised information on the costs or benefits arising from changes to accident and casualty numbers.

3.5.2 The method for assessing the impact of changes in accident and casualty numbers brought about due to proposals involving walking and cycling measures is summarised below. Further detail on this methodology and advice on its application can be found in **Guidance on the Appraisal of Walking and Cycling Schemes** (TAG Unit 3.14.1).

3.5.3 Accident impacts can be estimated by assessing how an intervention is likely to change the use of different types of transport infrastructure by various modes. The methods set out earlier in this Unit may be used to generate forecasts of accident impacts from mechanised vehicles. However this will not yield information on accident rates for cycling or walking activities, which must also be estimated, both for the 'with' and 'without' intervention scenarios.

3.5.4 Comparative studies of the performance of existing similar schemes and expert judgement can be used to aid the estimation of accident rates for walking and cycling activities. However, estimates of changes in accident rates for pedestrians and cyclists are likely to be relatively more sensitive to the detail of the design of walking and cycling interventions as a result of the comparatively small scale of such schemes. There is some evidence to suggest that increases in cycling activity do not result in an equivalent increase in the numbers of accidents involving cyclists, all other things being equal.

3.5.5 Once the estimated change in accident rates have been obtained, they must be combined with estimates of changes in the levels of walking and cycling activity in order to forecast the overall change in the number of casualties of different severities. Demand for new cycling and walking facilities should be modelled in accordance with TAG Unit 3.14.1.

3.5.6 An estimate of the monetary value of the change in the overall number of casualties should be derived by applying the values from Table 1. In the absence of any information on the breakdown of casualty severities, it may be possible to apply the value for preventing a Pedal Cyclist or Pedestrian injury from Table 2. This is equivalent to assuming a national average mix of injury severities for that mode. Advice from DfT should be sought in such instances.

3.5.7 The introduction of an intervention may also lead to mode shift, thereby reducing accidents associated with other modes. This would have the effect of increasing the value of a scheme where fewer road traffic accidents occur.

Where this is the case, such considerations must also be included in the appraisal.

4 Social and Distributional Impacts of Accidents

4.1 Introduction

4.1.1 This section provides additional advice on the technical processes to be considered in the assessment of the potential social and distributional impacts of changes in accidents resulting from transport schemes. The analyst should, in addition, make reference to **Detailed Guidance on Social and Distributional Impacts of Transport Interventions** (TAG Unit 3.17) in undertaking this work

4.2 Which groups of people are particularly vulnerable to the effects of accidents?

4.2.1 Most transport-related accidents, injuries and deaths occur on the road network. Research has shown that vulnerable groups (in terms of their accident risk) include children and older people (both particularly as pedestrians), young males and motorcyclists. There is also a strong link between deprivation and road accidents: children from social class V are five times more likely to be involved in a fatal road accident than those from social class I.

4.2.2 There are a number of groups of people who are particularly vulnerable to road collisions and should be addressed in the assessment of social impacts of transport schemes, and these should specifically address children and older people (particularly as pedestrians), as well as pedestrians, cyclists and motorcyclists as potentially vulnerable user groups. Young males are also relatively vulnerable as drivers, and this group should also be considered if there is evidence that they form a significant proportion of casualties on the road network. Impacts should also be considered, in terms of impacts of accidents on households in different social class (income) groups.

4.2.3 Consideration should also be given to the implications of accidents for users of the public transport network, particularly in terms of falls at bus stops and railway stations. Accidents involving fatalities are generally rare, but accidents involving trips and falls for transport users can result in serious injuries, which can often have serious implications for older people. In addition, suicides, whilst rare, are a significant cause of fatalities, whilst trespass on the railway is a major problem in some areas, which can occasionally result in serious accidents or even fatalities. This issue should also be considered for other segregated public transport modes, including guided bus.

4.3 Process to be followed

4.3.1 The approach to the assessment of the social and distributional impacts should follow the process described in **Detailed Guidance on Social and Distributional Impacts of Transport Interventions** (TAG Unit 3.17). . In terms of accidents, this follows the following five steps:

- Step 0: initial screening – this will identify if there are likely to be reductions in accidents or potential increases in accidents that cannot be eliminated through option design / mitigation;
- Step 1: identification of the area impacted by changes in accidents;
- Step 2: analysis of the demographic profile in the area impacted by changes in accidents;

- Step 3: a screening process, to determine if it is appropriate to undertake further analysis of the changes in accidents and the approach to be taken;
- Step 4: the analysis of social and distributional impacts of accidents; and
- Step 5: the collation and presentation of the outputs from the analysis.

4.3.2 The process to be followed for Steps 0-3 is described in TAG Unit 3.17.

4.3.3 In the event of accident impacts being identified from the screening process (Step 3), the sections below should be used to guide the technical analyses required in Steps 4 and 5 of this process.

4.3.4 The following section refers to the full appraisal process. TAG Unit 3.17 also notes that alternative approaches can be taken when impacts are neither significant nor concentrated. These are intended to be more proportionate and are more qualitative than the full appraisal. TAG Unit 3.17 sets out the principles that can be applied.

4.3.5 For both the full appraisal and the more proportionate qualitative appraisal, the promoter should develop a specification for the appraisal and agree this with the Department (or equivalent) before proceeding with the appraisal.

4.4 Analysis of Social and Distributional Impacts of Accidents (Step 4)

4.4.1 The analyst should analyse the accidents impacts of the scheme, in accordance with the guidance described in Sections 1, 2 and 3 of this TAG Unit.

4.4.2 The analyst should consider component parts of the scheme and assess the accident impacts of each component and also collectively. The approach should be proportionate. For example, a local public transport interchange improvement might have limited impact on area-wide traffic volumes and hence accidents over a wide area, but may have the potential to affect local traffic and numbers of vulnerable users at road junctions near the interchange. The analyst should make reference to Paragraphs 2.2.10 to 2.2.14 in TAG Unit 3.17 for detailed discussion of the approach to be taken to identifying the area impacted by the intervention in terms of accidents.

Rail Network

4.4.3 In the case of schemes on the rail network, primarily rail stations, the analyst should make reference to Section 3.2 of this TAG Unit, which highlights the legal requirement to ensure health and safety on the railways as far as is reasonably practicable. The analyst should collate data from the infrastructure owner and identify accidents at the station, and if there are any social groups that are vulnerable.

4.4.4 The Department has undertaken research, with stakeholders in the rail industry, into the causes and impacts of injuries on the rail network(see section 6).. For example, it is well understood that many of those suffering trips and falls on the rail network are elderly people. When elderly people suffer such injuries, the effects of the injury are often significantly worse than the effects on the average person. In the event that the analyst identifies trips and falls as a problem that needs to be addressed, the groups suffering such injuries should be investigated, and the impacts of the scheme on these groups should be assessed.

4.4.5 Where other issues, such as suicide and trespass, are known to be a problem, the analyst should seek data on the groups that are prone to committing suicide and trespass on the railway. The analyst should then consider the potential impacts of the scheme (in terms of the scope for preventing suicide and trespass), and the potential impacts of the scheme on these groups should be assessed.

Road Network

4.4.6 In the case of schemes affecting the road network, the analyst should make reference to Section 3.1 of this TAG Unit for highway schemes, Section 3.3 for public transport schemes affecting the highway network, and Section 3.5 for walking and cycling schemes.

4.4.7 STATS19 casualty data should be mapped (using GIS) for the area impacted by the scheme and the causes of collisions on the road network identified. This data will be an essential input to the wider analysis of road safety impacts, as previously described in this TAG Unit, with the first step being to identify casualty hotspots on the network either in spatial terms (clusters) or as an exceedence of average casualty rates for the road class (casualties per 100,000 veh-km).depending on local practice.

4.4.8 This work is already required in the core accident analysis, and there should therefore be no additional burden to the analyst. The process will take place in parallel with and will be informed by the appraisal of road safety impacts using COBA (or other appropriate analytical tool if used) in the impacted area.

4.4.9 This information should then be used, together with the findings of the demographic analyses, to identify clusters of potential vulnerable groups that are casualties on the road network, at individual junctions and along individual links. This should include, as a minimum, the identification of the following potential vulnerable groups of people:

- **Children;**
- **Older people;**
- **Young males (including young males as car drivers);**
- **Pedestrians (including specific reference to children and older people as pedestrians);**
- **Cyclists; and**
- **Motorcyclists.**

4.4.10 This analysis should make the best use of STATS19 data to identify if these groups form a significant proportion of overall casualties. In addition, if the demographic profiling has identified deprived areas, the analyst should carefully consider if there is any evidence of casualty rates in the deprived area being higher than national average rates.

4.4.11 Within this step it is essential to understand the underlying issues inherent in any identified accident problems. High-level numerical analysis alone is unlikely to reveal the underlying issues and without such understanding the design of intervention strategies is weakened. This is particularly true when considering the design of non-engineering measures, where the design of such interventions will be highly dependant on whether the casualties occur within a deprived area or live in a nearby deprived area.

4.4.12 This step will then need to consider the implications of physical changes to road layout, changes in traffic flows / speeds and changes in pedestrian and cyclist activity. This data will feed into the COBA analysis that is already required in this TAG Unit.

Detailed Analysis

4.4.13 The detailed analysis should comprise the following elements, for each link and junction on the road network:

- Analysis of the effects of physical changes in road layout;
- Analysis of the effects of changes in traffic flows and speeds; and
- Analysis of the effects of changes in numbers of particularly vulnerable user groups on the network, namely pedestrians, cyclists and motorcyclists.

4.4.14 Most areas of study for transport interventions include large numbers of links on the road network, and hence an efficient and proportionate approach to appraisal is required. Whilst the physical changes in road layout are likely to be limited to a relatively small number of links, changes in flows and speeds tend to occur on a large number of links on the network, particularly in urban areas.

4.4.15 It is therefore recommended that the analyst makes use of COBA or other computer analyses, where these have been undertaken, to systematically calculate the impacts of changes in flows and speeds, together with changes in road layout, on the numbers of accidents and casualties, initially at link level and then for the network as a whole.

4.4.16 Computer analysis does not, however, provide information on the numbers of casualties amongst the potential vulnerable groups of interest for the social and distributional impacts.

4.4.17 The analyst should first identify the links on the network where there are high casualty frequencies for the vulnerable groups. These current casualty rates should then be compared against the forecast changes in accidents for the areas of interest on the network. It is recommended that the analyst uses spreadsheet modelling techniques, using computer outputs of the changes in total accidents, where there are a large number of links or junctions. The guidance in Table 6 should be used to estimate the benefit to each vulnerable group for each link on the network.

Table 6 – Grading of accident SDIs for vulnerable groups at link/junction level

Change in number of accidents on each link/junction	Existing casualty frequency rate for each group of vulnerable users		
	Low (more than 30% lower than average rate for road class)	Medium (<30% lower to <30% higher than average rate for road class)	High (more than 30% higher than average rate for road class)

Significant reduction (>30%)	Moderate Beneficial	Moderate Beneficial	Large Beneficial
Slight reduction (<30%)	Slight Beneficial	Slight Beneficial	Moderate Beneficial
No significant change (<5% reduction or <5% increase)	Neutral	Neutral	Neutral
Slight increase (<30%)	Slight Adverse	Slight Adverse	Moderate Adverse
Significant increase (>30%)	Moderate Adverse	Moderate Adverse	Large Adverse

4.4.18 For example, if the detailed analysis has demonstrated that the link currently has a high casualty frequency for children, and the computer analysis forecasts an overall 40% reduction in accidents on the link, the assessment for children will be large beneficial.

4.4.19 The individual assessments for each potential vulnerable group, for each link, should then be collated and an overall score defined, using the seven-point scale, from large beneficial to large adverse. A qualitative statement should be added to the overall assessment score, particularly in cases where there are both beneficial and adverse impacts on different links.

Smaller scale interventions on road network

4.4.20 If computer analysis has not been undertaken, for example in the case of smaller interventions on the road network (for example an individual road safety scheme or a new pedestrian crossing), the guidance in Table 6 may still be used using manual inputs. The worksheet in Table 7 below can be used to provide an additional assessment of the impacts on each vulnerable group for each link / junction to provide a check against the initial output from Table 6, if this is considered necessary by the analyst. This check should be based on consideration of changes in physical road layout, changes in traffic flows and speeds and the volume of pedestrian and cyclist activity in the area.

Table 7 – Worksheet for assessing accident SDIs for smaller schemes

Link Reference: ____________________
Vulnerable casualty group: ___________

	Existing casualty rate for vulnerable users Defined vulnerable casualty group: _______________		
	Low (more than 30% lower than average rate for class of road)	Medium <30% lower to <30% higher than average for class of road	High (more than 30% higher than average rate for class of road)
1. Change in physical layout that could impact on defined vulnerable group			
Significant improvement	Moderate Beneficial	Moderate Beneficial	Large Beneficial
Slight improvement	Slight Beneficial	Slight Beneficial	Moderate Beneficial
Neutral	Neutral	Neutral	Neutral
Slight worsening	Slight Adverse	Slight Adverse	Moderate Adverse
Significant worsening	Moderate Adverse	Moderate Adverse	Large Adverse
2. Change in traffic flow OR speed			
Significant reduction (>15% decrease)	Moderate Beneficial	Moderate Beneficial	Large Beneficial
Slight reduction (>5%, <15% decrease)	Slight Beneficial	Slight Beneficial	Moderate Beneficial
Neutral (<5% increase or decrease)	Neutral	Neutral	Neutral
Slight increase (>5%, <10% increase)	Slight Adverse	Slight Adverse	Moderate Adverse
Significant increase (>10% increase)	Moderate Adverse	Moderate Adverse	Large Adverse

3. Change in numbers of pedestrians, cyclists and motorcyclists

The evidence on the impacts of changes in numbers of pedestrians and cyclists on overall numbers of casualties is not conclusive. Some practitioners consider that increased numbers of cyclists on the road network result in increased visibility for the group, encouraging drivers to modify their behaviour. It is therefore the responsibility of the analyst to consider the implications of changes in the numbers of pedestrians and cyclists and judge the implications for road safety of vulnerable road users accordingly.

Motorcyclists are highly vulnerable users of the road network. Careful consideration should be given to the potential road safety implications of measures that could result in changes to numbers of motorcyclists on the network.

Overall assessment for link, based on criteria 1, 2 and 3 above: ____________________________
Qualitative Commentary: ____

4.4.21 This worksheet should be used for each of the potential vulnerable user groups for each of the links/junctions affected by the transport scheme. The approach set out in Table 7 is only intended for smaller schemes in which a small number of links would be affected by physical changes in road layout and modest changes in traffic flows and / or speeds.

4.4.22 In these cases, the overall assessment of the impact on each of the defined potential vulnerable groups should then be scored using the scale from large beneficial to large adverse, based on the scores derived from individual links.

4.4.23 The process should use the following criteria to determine the overall assessment score:

- A majority vote of overall scores is used to determine the final score;
- For an equally split number of scores the analyst should choose the more conservative score; and
- For an equally shared scoring the analyst should choose the midway score.

4.4.24 A worked example of this approach for a small scheme is provided in Table 8.

4.4.25 In the event of a negative impact score this must be highlighted in the assessment, with a supporting qualitative statement.

4.4.26 A qualitative statement should be added to the overall assessment score, particularly in cases where there are both beneficial and adverse impacts on different links.

Report to Project Manager and Design Team

4.4.27 In the event of any adverse impacts, in which there is forecast to be an increase in the number of vulnerable casualties, the analyst should report the findings to the Project Manager.

4.4.28 In the case of beneficial impacts, the analyst should report back to the Project Manager, in order that the benefits can be captured in subsequent acceptability analyses for the scheme.

4.5 Outputs from Appraisal of Social and Distributional Impacts (Step 5)

4.5.1 The main outputs produced as a result of the road safety appraisal process will be a series of analyses, which should then be used to provide the overall assessments of the road safety impacts for each social group, ranging from large beneficial to large adverse, depending on the scale of impact.

4.5.2 Table 8 below sets out an example of part of this analysis for vulnerable groups that have been identified for a smaller transport scheme. In this case, young males (as drivers) have also been identified as a specific vulnerable group within the area, and it is appropriate to consider the potential impacts on this specific group of road users. A similar table would be required to report junction effects if these had been assessed separately to link effects.

Table **8 – Example of a summary analysis for a smaller scheme**

Link	Vulnerable social groups			Vulnerable network users		
	Children	Older People	Young Males	Ped-estrians	Cyclists	M/cyclists
1	Slight ben.	Mod. ben.	Neutral	Mod. Ben.	Slight ben.	Neutral
2	Mod. ben.	Mod. ben.	Neutral	Mod. Ben.	Mod. Ben.	Neutral
3	Slight ben.	Mod. ben.	Neutral	Mod. Ben.	Slight ben.	Neutral
4	Slight ben.	Mod. ben.	Slight ben.	Mod. Ben.	Slight ben.	Mod. ben.
5	Slight ben.	Mod. ben.	Neutral	Mod. Ben.	Slight ben.	Neutral
6	Neutral	Neutral	Slight ben.	Neutral	Neutral	Slight ben.
7	Neutral	Slight ben.	Neutral	Slight ben.	Neutral	Neutral
Overall	**Slight ben.**	**Mod. ben.**	**Slight ben.**	**Slight ben.**	**Slight ben.**	**Slight ben.**

4.5.3 In the case of larger schemes, in which there are potentially large numbers of links, the approach should be automated, for example through the use of spreadsheet tools.

4.5.4 The scores for each of the groups under consideration should then be reported in the matrix of social and distributional impacts, described in Step 5 of **Detailed Guidance on Social and Distributional Impacts of Transport Interventions** (TAG Unit 3.17).

5 Further Information

5.1.1 This TAG Unit replaces the twenty-eighth in a regular series of the **Highways Economic Note No.1** (HEN 1) on Valuation of Accidents. The HEN 1 will no longer be published as a stand-alone document. Updates to accident appraisal guidance, including the values for prevention of road accidents and casualties, will be set out in the Department's Transport Analysis Guidance.

5.1.2 All values given in this Unit, including those in the Tables, are expressed in 2009 market prices. Values for base dates other than 2009 can be obtained as described in Section 2.3 'Uprating of Values' and in the COBA Manual. To ensure that appraisal evidence can be consistently compared across schemes, the results of NATA appraisals must always be presented using the price base year of 2002. For convenience, the values for prevention of road accidents and casualties by severity are provided in 2002 prices and values in Annex A.

5.1.3 Further information on the use of accident or casualty values may be requested from the Department using the contact details given at the end of this Unit. More detailed information on the methodology for valuation of road accidents is available in the Road Accidents Great Britain articles and research reports listed below. TRL reports are available from TRL Ltd, Wokingham, Berkshire (telephone 01344 773131, e-mail: enquiries@trl.co.uk). Information on accident numbers and rates (rather than costs) may be obtained from two annual The Stationery Office / DfT publications, Reported Road Casualties Great Britain, and Transport Statistics Great Britain. Previous editions of Highways Economic Notes No.1 can be found on the Department's web site at http://www.dft.gov.uk/pgr/roadsafety/ea/.

5.1.4 The following documents provide information that follows on directly from the key topics covered in this Unit.

For information on:	**See:**	**TAG Unit number:**
The background and overall approach to the Social and Distributional Impacts of transport schemes	Detailed Guidance on Social and Distributional Impacts of transport schemes	TAG Unit 3.17

6 References

The following documents provide information that follows on directly from the key topics covered in this Unit.

Chilton, S., Covey, J., Hopkins, L., Jones-Lee, M., Loomes, G., Pidgeon, N. & Spencer, A. (1998) New research results on the valuation of preventing fatal road accident casualties, In: **Road Accidents Great Britain 1997, The Casualty Report**, Department of the Environment Transport and the Regions.

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Hopkin, J.M. and O'Reilly, D. (1993) **Revaluation of the Cost of Road Accident Casualties: 1992 Revision**, TRL Research Report 378, Transport Research Laboratory, Wokingham.

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Office for Rail Regulation (ORR, 2008a): **Internal guidance on cost benefit analysis (CBA) in support of safety-related investment decisions**. Available at:
http://www.rail-reg.gov.uk/upload/pdf/risk-CBA_sdm_rev_guid.pdf

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http://www.rssb.co.uk/pdf/reports/research/T440_rb_final.pdf

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Taylor, M.C. (1990) **The cost of vehicle damage resulting from road accidents**, TRL Research Report RR256, Transport and Road Research Laboratory, Wokingham.

7 Document provenance

This Transport Analysis Guidance (TAG) Unit is based on Chapter 5, Section 2 of **Guidance on the Methodology for Multi-Modal Studies Volume 2** (DETR, 2000) and on the **Highways Economics Note No.1** (DfT, 2007).

This unit has been updated in January 2010 to reflect the guidance on Social and Distributional Impacts.

The valuation of accidents has been updated in January 2011.

This Unit is now definitive.

Technical queries and comments on this Unit should be referred to:

Integrated Transport Economic Appraisal (ITEA) Division

Department for Transport
Zone 3/04 Great Minster House
76 Marsham Street
London SW1P 4DR
itea@dft.gsi.gov.uk
Tel 020 7944 6176
Fax 020 7944 2198

Annex A:

Table A: 2002 values of prevention per casualty by severity	
Injury severity	£ June 2002
Fatal	**1,249,890**
Serious	**140,450**
Slight	**10,830**
Average, all casualties	**40,290**

Table B: Costs per accident, June 2002 prices and values

Accident severity	**Damage to Property**			**Police cost**			**Insurance and admin**
	Urban	Rural	Motorway	Urban	Rural	Motorway	
Fatal	5977	10136	12894	1463	1387	2030	230
Serious	3203	4620	11002	122	341	320	143
Slight	1890	3063	5566	44	44	44	87
Damage only	1352	2019	1941	3	3	3	42