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A STUDY OF TRAFFIC CONFLICTS AT SIX INTERSECTIONS

by

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Ownership of the Transport Research Laboratory was transferred from the Department of Transport to a subsidiary of the Transport Research Foundation on 1st April 1996.

A STUDY OF TRAFFIC CONFLICTS AT SIX INTERSECTIONS

ABSTRACT

Traffic conflict data have been obtained for six intersections using the technique of observation and definition of conflicts established in a previous study at one of the sites. Serious conflict and injury accident frequencies are shown to be positively related between different junctions and between different locations within a given junction. These data validate the use of the traffic conflict technique as a relatively rapid method of study of junction safety. At each intersection studies of vehicle speed and flow have been made and the important influence on conflicts of vehicles other than those primarily involved has again been shown.

1. INTRODUCTION

A relation of conflicts with injury accidents has been shown to exist in a pilot study at a rural dual carriageway intersection.[1] Simple conflicts, defined as situations involving one or more vehicles taking evasive action did not correlate closely with reported injury accidents, but serious conflicts, defined as situations involving a vehicle in at least a sudden rapid deceleration or lane change to avoid collision correlated well with reported injury accidents both in time of day and location. The same conflict criteria developed in the pilot study have now been applied to several intersections, (including the one used in the initial study) covering a wide range of accident rates, to establish whether serious conflicts can be used in place of accidents, as a measure of hazard, at different types of intersection. A comparison of the numbers of injury accidents and serious conflicts at these six intersections is made in this report and factors in conflict generation at each site investigated.

2. METHOD

In addition to the site already used five sites with known injury accident records were chosen. Details of all site layouts are given in Figure 1 and their locations in Table 1. Each site was visited by a team of observers and all conflicts occurring over a ten hour period on an average weekday were identified and graded by the severity of the event, according to the criteria established in the pilot study at site 1. These were:-

1. Precautionary braking (ie for vehicle waiting to enter junction), precautionary lane change, anticipatory braking or lane change when risk of collision minimal.

2. Controlled braking or lane change to avoid collision but with ample time for manoeuvre.

3. Rapid deceleration, lane change or stopping to avoid collision; resulting in a near miss situation. No time for steady controlled manoeuvre.

4. Emegency braking or violent swerve to avoid collision resulting in a very near miss situation or minor collision.

5. Emergency action followed by collision.

Only 3, 4 and 5 are classified as "serious conflicts".

The conflict data were entered on a sheet designed for each intersection with the conflict definitions given for the range of five severities. An example of such a data sheet is shown in Figure 2. A diagram of the occurrence can be drawn in the space provided and details entered of vehicle manoeuvres both of those directly and indirectly involved. The colours and types of vehicles and the time at which the conflict occurred were noted. This was also of assistance for quick identification of the occurrence on the film record. Actions taken by drivers such as swerving, sounding horn, flashing headlights, emergency braking causing tyre squeal, and any other relevant information were entered on the sheet. The severity of the event was noted by a tick made in the box next to the appropriate conflict severity definition. Continuous filming was carried out during the study period using a 16 mm cine camera running at a speed of 2 frames per second. The camera was mounted on an hydraulic tower the height of which may be adjusted up to 13 metres above the road. An overall view of the intersection can thus be obtained. The film gave a complete record of all events taking place within the intersection and enabled flow counts of all manoeuvres to be made and an analysis of each conflict situation, from the initial stage through to the dispersal, to be undertaken. Speed measurements were made of vehicles on the roads approaching the junction using radar speed meters.

3. RESULTS

3.1 Conflicts

For each of the six intersections all conflicts that occurred during the ten hour study period were noted on the data sheet. A severity classification was made using the gradings given on the data sheet, shown in Figure 2, and the number of serious conflicts (grades 3, 4, 5 in Figure 2) tabulated for each intersection. The serious conflict data was chosen as the pilot study had shown a relation between these conflicts and injury accidents. The data are given in Table 1 of the number of serious conflicts occurring at each intersection during the study period. The manoeuvre generating each conflict, the involvement of other vehicles in the situation and details of the type of conflict were also studied from the film record.

3.2 The relation of conflicts with accidents

Personal injury accidents occurring over a three year period at each of the intersections were studied, with the exception of the A40/A436 intersection which had only been constructed a year previously. The data for this junction were therefore multiplied by 3. The numbers of injury accidents in a 3 year period

for each intersection are given in Table 1. A graph showing the number of serious conflicts over a 10 hour day plotted against the number of injury accidents over 3 years, for each site is shown in Figure 3. The rank correlation coefficient calculated from the data in Table 1 gave a value of rs = 1, statistically significant at 0.1% level.* The very high correlation between injury accidents and serious conflicts between these six intersections shows that the conflict technique can be used in comparative studies between junctions. The pilot study at site 1 showed that serious conflicts and injury accidents correlated by location within the junction. Figure 4 gives details of the percentages of total numbers of serious conflicts and injury accidents occurring at site 1 and two other junctions where there are sufficient accidents and conflicts for this type of analysis. Tables 2, 3, and 4 locate accidents and conflicts for three junctions by the manoeuvre within the intersection in which they occur. Spearman rank correlation coefficients were calculated between injury accidents and serious conflicts for the three junctions and were 0.93, 0.88 and 0.97 respectively, and are each statistically significant at the 1% level showing that in these cases serious conflicts are an excellent indicator of the postion of injury accidents. The data from Table 5, where the serious conflicts and injury accidents at all six junctions were ranked by carriageway of occurrence, gave a correlation coefficient of 0.97 statistically significant at 0.1% level. This shows that the numbers of serious conflicts and injury accidents correlate very highly not only in overall numbers between junctions but by position within the junction as well.

On average a driver is involved in an injury accident once in about 47 years. If the ratio of conflicts to accidents is approximately constant over the whole of the road system then on average a driver is involved in one serious conflict during about 200 miles of driving ie one serious conflict per week.

3.3 Vehicle involvement in conflicts

The part played by the presence of other vehicles, involved in conflicts, other than the basic two taking evasive action, was shown in the earlier study of site 1. The importance of this was shown by the fact that about 75% of serious conflicts involved more than two vehicles. A vehicle is judged to be involved if its presence affects the possible manoeuvres of the vehicles actually in conflict. At all six intersections studied for this report the number of vehicles involved in the serious conflicts was noted and Table 6 gives the percentage of serious conflicts involving 2, 3, 4 or 5 and more vehicles. Every junction had at least 54% of serious conflicts involving more than two vehicles.

At the dual carriageway staggered intersections the most common situations involving multi-vehicle conflicts are summarised in Table 7 and are as follows:

a. A vehicle in the nearside lane or deceleration lane blocks the view of both major and minor road vehicles and restricts the evasive action of offside lane vehicles coming into conflict with the crossing vehicle. This situation is shown in Figure 5(a). Almost one third of all dual carriageway serious conflicts fell within this category; 30% at Bar End (A33) and 29% at Andoversford (A40).

b. The leading vehicle of a pair emerging from the minor road is 'followed out' by the second, which is then involved in conflict with the major road traffic if the leading vehicle slows or stops on entering the central reserve. 22% of the serious conflicts at Bar End (A33) and 18% of the serious conflicts at Andoversford (A40) were due to this cause. Figure 5(b) shows the situation diagramatically.

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* The possibility of the correlation occurring by chance is less than one in a thousand.

c. A crossing vehicle may be in conflict with the major road traffic when the central reserve gap is occupied by delayed vehicles going in the same direction or by vehicles entering from the opposite carriageway. When the right turning flow from the minor road and the turning flow into the minor road from the opposite side is appreciable the reserve gap at the junctions studied is not sufficiently large. Not more than three vehicles can be accommodated at any one time and therefore this type of conflict can often occur. 12% of the serious conflicts at Bar End (A33) and 21% of the serious conflicts at Andoversford (A40) were due to central reserve blockage. Figure 5(c) shows the situation diagramatically.

At single carriageway intersections the conflict situations involving more than two vehicles were again mainly of three types. Firstly the 'follow out' situation previously described occurred. Secondly the right turn from the major road into the minor road involved several vehicles especially when overtaking took place in the major road streams. Thirdly 'hooking' conflicts occurred particularly between right turning vehicles from each arm of the minor road. These conflict situations are shown diagramatically in figures 6a, b, c and the percentages of these types of serious conflict given in Table 8.

3.4 Vehicle flow and speed

Flow counts over the 10 hour period were made from the films in all flow directions at each intersection. Tables 9, 10, 11, give mean flows for each manoeuvre, the three left/right staggered dual carriageway intersections being directly compared in Table 9, the two single carriageway crossroads in Table 10, and the splay junction in Table 11. Table 5 gives the flow data for each intersection by carriageway direction tabulated against number of injury accidents and serious conflicts for those carriageways. Ranking flow against injury accidents and flow against serious conflicts the correlation coefficients obtained were 0.15 and 0.20 respectively, both not statistically significant. It would therefore appear that there is no relation between total flow into these intersections and serious conflicts. A plot has been made of crossing flow multiplied by major road flow against numbers of serious conflicts for each of the six conflict generating manoeuvres shown in Figure 4, at the two dual carriageway intersections. This plot is shown in Figure 7. Numbers of serious conflicts tend to increase with increasing flow but there is a large scatter of values showing that possibly for some manoeuvres flow influences serious conflict generation whereas in others it is only a small factor. In a multiple factor situation such as occurs at a complex intersection, flow is only one of the factors that influence the accident and serious conflict rate. All factors including vehicle speed, carriageway visibility, signing, trees and fences, turning vehicles, manoeuvres of other vehicles etc are inter related, for instance a decrease in flow may not give a decrease in conflicts because it has led to an increase in vehicle speeds. Similarly improvements in visibility, signing etc may have effects on other factors and so give little apparent improvement in the accident situation. It would appear therefore that to enable a full assessment of remedial measures to be made each manoeuvre in each intersection should be assessed individually to obtain the factors important in the generation of the serious conflict situations.

Speeds were measured on the roads approaching the intersection 80 metres from it. Table 12 shows the mean, maximum and minimum speeds measured for each approach for each dual carriageway junction, and Table 13 those for the other three junctions. The high speeds at some of the intersections may have created difficulties for drivers crossing from the minor road but no evidence has been found that at a given site the vehicles travelling at higher speeds were involved in more conflicts than those travelling at about the average speed. The effect of speed is again very complex and must be studied in relation to all the other site factors.

4. CONCLUSIONS

1. Further data have been obtained to confirm that serious conflicts correlate well with the injury accident data for different types of intersection.

2. Over the six intersections studied the number of serious conflicts observed was proportional to the number of injury accidents recorded.

3. At three sites, including the one used in the earlier study, the location of the conflicts identified in order of importance the location of the reported injury accidents. At the other three sites the locations tended to be related but numbers were too small to firmly establish the relation.

4. At each of the sites studied at least 54 per cent of serious conflicts involved the presence of more than the two vehicles actually in conflict and these additional vehicles were judged to have affected the possible manoeuvres of the conflicting vehicles.

5. No clear relation has been shown between flow and the serious conflict or injury accident rates. The effect of vehicle flow and speed patterns on the conflict and accident rate appears to be complex.

6. The study has been successful in showing that data on serious conflicts can provide information enabling junctions to be ranked in order of safety. Ten hours observation at each site has provided complementary relevant data to the three years reported accidents, to indicate the important situations leading to conflicts and accidents.

5. ACKNOWLEDGEMENTS

The work described in this report forms part of the research programme of the Road User Characteristics Division (Leader K Russam). Members of the Division concerned with the research were S J Older, A H Wheeler and the author. The help of the photographic section is gratefully acknowledged.

6. REFERENCES

1. SPICER B R. A study of traffic conflicts at a rural dual carriageway intersection. *Department of the Environment, RRL Report* LR 410. Crowthorne, 1971 (Road Research Laboratory).

TABLE 1

Comparison of number of serious conflicts and injury accidents at six intersections

Junction Number	Location	Number of injury accidents in 3 years	Number of serious conflicts in 10 hours
1	A33/Bar End Road	48	52
2	Feltham Road/ Clockhouse Lane	36	40
3	A40/ A436	33*	31
4	A30/ B3013	14	17
5	A30/Fleet Road (Flats Cross)	9	9
6	A30/ A287	6	8

* Based on eleven accidents during the one year following construction

TABLE 2

Injury accidents and serious conflicts at Bar End Junction by manoeuvre involved

Manoeuvre	% of serious conflicts occurring	Rank	% of injury accidents occurring	Rank
Right turn from Bar End Road crossing to the central reserve	45	6	35	5.5
Left turn from Bar End Road, followed by right turn to central reserve, for Morestead	18	5	35	5.5
Right turn from central reserve toward Basingstoke	2	1	0	1
Right turn from Morestead Road crossing to the central reserve	4	2	5	2
Left turn from Morestead Road followed by right turn into central reserve for Winchester	17	4	10	3
Right turn from central reserve toward Southampton	14	3	15	4

TABLE 3

Injury accidents and serious conflicts at A40/A436 junction Andoversford by-pass by manoeuvre involved

Manoeuvre	% of serious conflicts occurring	Rank	% of injury accidents occurring	Rank
Right turn from Stow Road crossing to the central reserve	45	6.5	60	7
Left turn from Stow Road followed by right turn into the central reserve for Andoversford	45	6.5	40	6
Right turn from the central reserve toward Oxford	0	2	0	3
Right turn from Andoversford crossing to the central reserve	0	2	0	3
Left turn from Andoversford followed by right turn into the central reserve for Stow	4	4	0	3
Right turn from central reserve toward Cheltenham	0	2	0	3
Left turn from A40 into Stow Roadm	6	5	0	3

TABLE 4

Injury Accidents and Serious Conflicts at
Clockhouse Lane/Feltham Road/Convent Road intersection, Ashford

Manoeuvre	% of serious conflicts occurring	Rank	% of injury accidents occurring	Rank
Crossing from Convent Road to Clockhouse Lane in conflict with vehicle from Ashford	40	6	47	6
Crossing from Convent Road to Clockhouse Lane in conflict with vehicle from Feltham	23	5	21	5
Crossing from Clockhouse Lane to Convent Road in conflict with vehicle from Ashford	17	4	13	3.5
Crossing from Clockhouse Lane to Convent Road, in conflict with vehicle from Feltham	10	3	13	3.5
Right turn from Clockhouse Lane, in conflict with vehicle from Feltham	3	1	2	1.5
Left turn into Clockhouse Lane, in conflict with vehicle from Ashford	7	2	2	1.5

TABLE 5

Variation of accidents and conflicts with flow for six intersections

Intersection	Carriageway	Flow (mean total crossing flow x mean major road flow)	Rank	Number of injury accidents in 3 years	Rank	Number of serious conflicts in 10 hours	Rank
1 A 33 Bar End Rd	Southbound	189×10^3	11	14	9	18	9
	Northbound	185×10^3	10	34	12	34	12
2 Feltham Rd Clockhouse La.	Westbound	100×10^3	5.5	13	8	15	8
	Eastbound	98×10^3	4	23	10	25	10
3 A 40 A 436	Eastbound	34×10^3	3	33	11	30	11
	Westbound	33×10^3	2	0	1	1	1
4 A 30 B 3013	Westbound	110×10^3	7	8	7	8	6
	Eastbound	100×10^3	5.5	6	5.5	9	7
5 A 30 Fleet Rd	Westbound	116×10^3	9	3	3	4	3
	Eastbound	111×10^3	8	6	5.5	5	4.5
6 A 30 A 287	Westbound	195×10^3	12	3	3	5	4.5
	Eastbound	29×10^3	1	3	3	3	2

TABLE 6

Percentage of serious conflicts involving 2, 3, 4, 5 or more vehicles, for six intersections

Junction Number	Number of vehicles involved in serious conflict			
	1 + 1	1 + 2	1 + 3	1 + 4 or more
1	26%	34%	22%	18%
2	42%	42%	5%	11%
3	40%	32%	21%	7%
4	46%	30%	15%	9%
5	42%	30%	14%	14%
6	30%	50%	10%	10%

TABLE 7

Types of conflicts at dual carriageway intersections
(Percentages are of all serious conflicts at junction)

Junction	Follow out	Blocking of central reserve	Blocking of view by approaching vehicle
Bar End A33	22%	12%	30%
Andoversford A40	18%	21%	29%
Flats Cross A30	Too few conflicts to split into specific types		

TABLE 8

Types of serious conflicts at non-dual carriageway intersections

Junction	Follow out	Vehicle turning right in conflict with overtaking vehicle	Hooking conflicts
Ashford	14%	8%	10%
Minley A30	14%	14%	30%
Dorchester Arms A30	Too few conflicts to split into specific types		

TABLE 9

Mean flow for each manoeuvre in vehicles/hour,
three dual carriageway left/right staggered intersections

	Manoeuvre numbers as figure 1											
Junction Number	1	2	3	4	5	6	7	8	9	10	11	12
1	152	623	14	11	657	28	18	55	135	11	57	15
3	80	153	3	6	145	7	5	60	84	6	62	7
5	3	600	5	5	583	10	8	55	69	10	52	6

TABLE 10

Mean flow for each manoeuvre (vehicles/hour),
two single carriageway intersections

	Manoeuvre numbers as figure 1											
Junction Number	1	2	3	4	5	6	7	8	9	10	11	12
2	30	230	37	85	220	10	18	155	25	45	145	90
4	22	553	19	53	539	32	39	56	13	21	51	47

TABLE 11

Mean flow for each manoeuvre (vehicles/hour)

	Manoeuvre numbers as figure 1											
Junction Number	1	2	3	4	5	6	7	8	9	10	11	12
6	708	4	21	257	5	16	620	234	6	13	5	3

TABLE 12

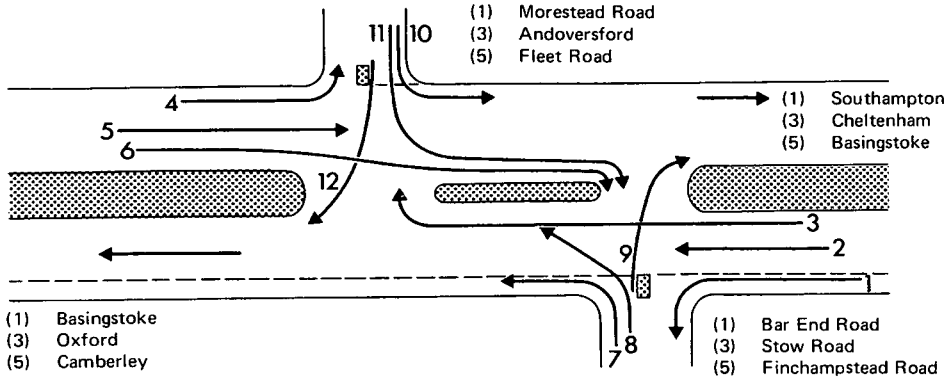
Speed measurements on the major road at three dual carriageway intersections

Junction Number	Direction	Speed (mile/h)		
		Mean	Max	Min
1	A33 Northbound	50	78	27
1	A33 Southbound	45	77	29
3	A40 Eastbound	50	77	32
3	A40 Westbound	44	69	28
5	A30 Eastbound	47	75	30
5	A30 Westbound	47	66	31

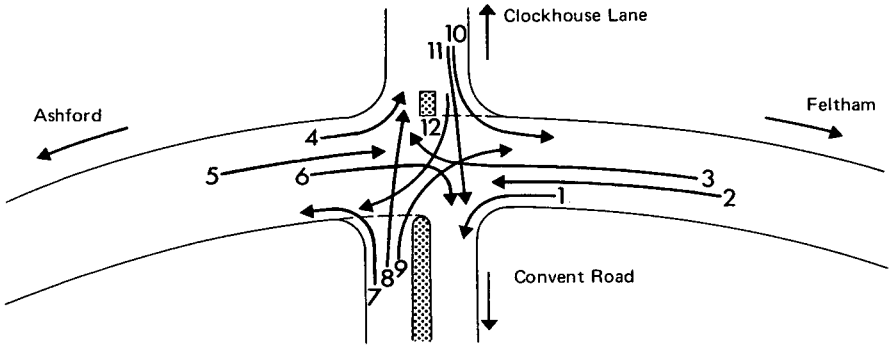
TABLE 13

Speed measurements on the major road at three intersections

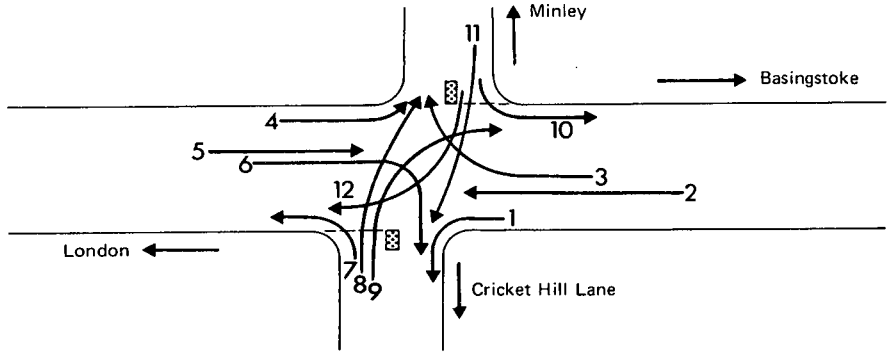
Junction Number	Direction	Speed (mile/h)		
		Mean	Max	Min
2 (30 mile/h limit)	Eastbound	25	40	15
	Westbound	28	42	15
4	A30 Eastbound	46	62	33
	A30 Westbound	45	62	26
6	A30 Eastbound	44	67	31
	A30 Westbound	44	72	26



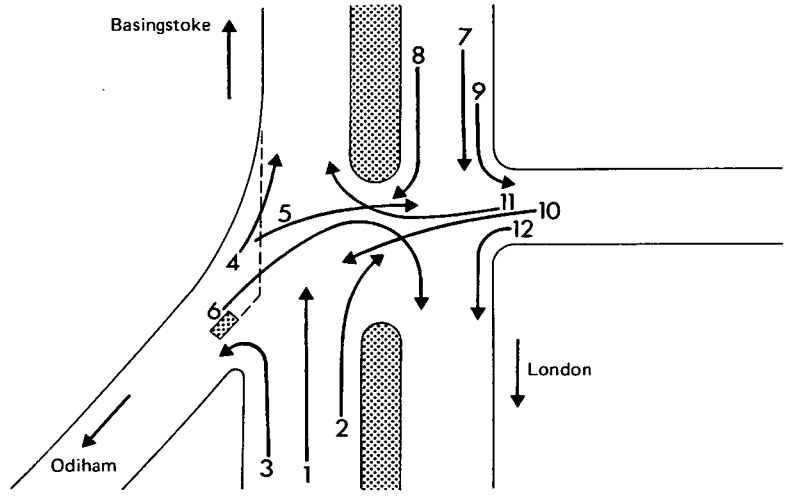
Junctions 1, 3, 5, were left/right staggers on dual carriageways.



Junction 2 was a cross roads in an urban situation with one approach road dual carriageway



Junction 4 was a single carriageway rural cross roads with a right/left stagger of the minor road



Junction 6 was a splay junction. The section of major road at the junction was dual carriageway

FIG 1 LAYOUTS OF THE INTERSECTIONS STUDIED WITH FLOW DIRECTIONS

CONFLICT REPORT SHEET DATE:

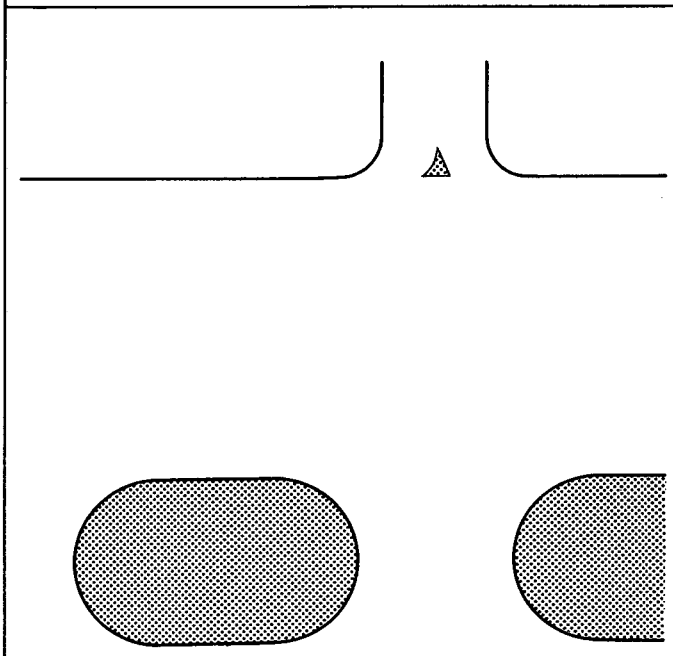
DIAGRAM OF OCCURRENCE		CONFLICT SEVERITY	
	1	Precautionary conflict. (i.e. braking for vehicle waiting to emerge, precautionary lane change, or anticipatory braking.)	
	2	Controlled braking or lane change to avoid collision but with ample time for the manoeuvre.	
	3	Rapid deceleration, lane change or stopping to avoid collision, resulting in a near miss situation. No time for steady controlled manoeuvre.	
	4	Emergency braking or violent swerve to avoid collision resulting in very near miss situation, or occurrence of a minor collision.	
	5	Emergency action, followed by collision.	
TIME 	Note on diagram direction, colour, vehicle type, and evasive action taken.		

FIG.2 CONFLICT REPORT SHEET

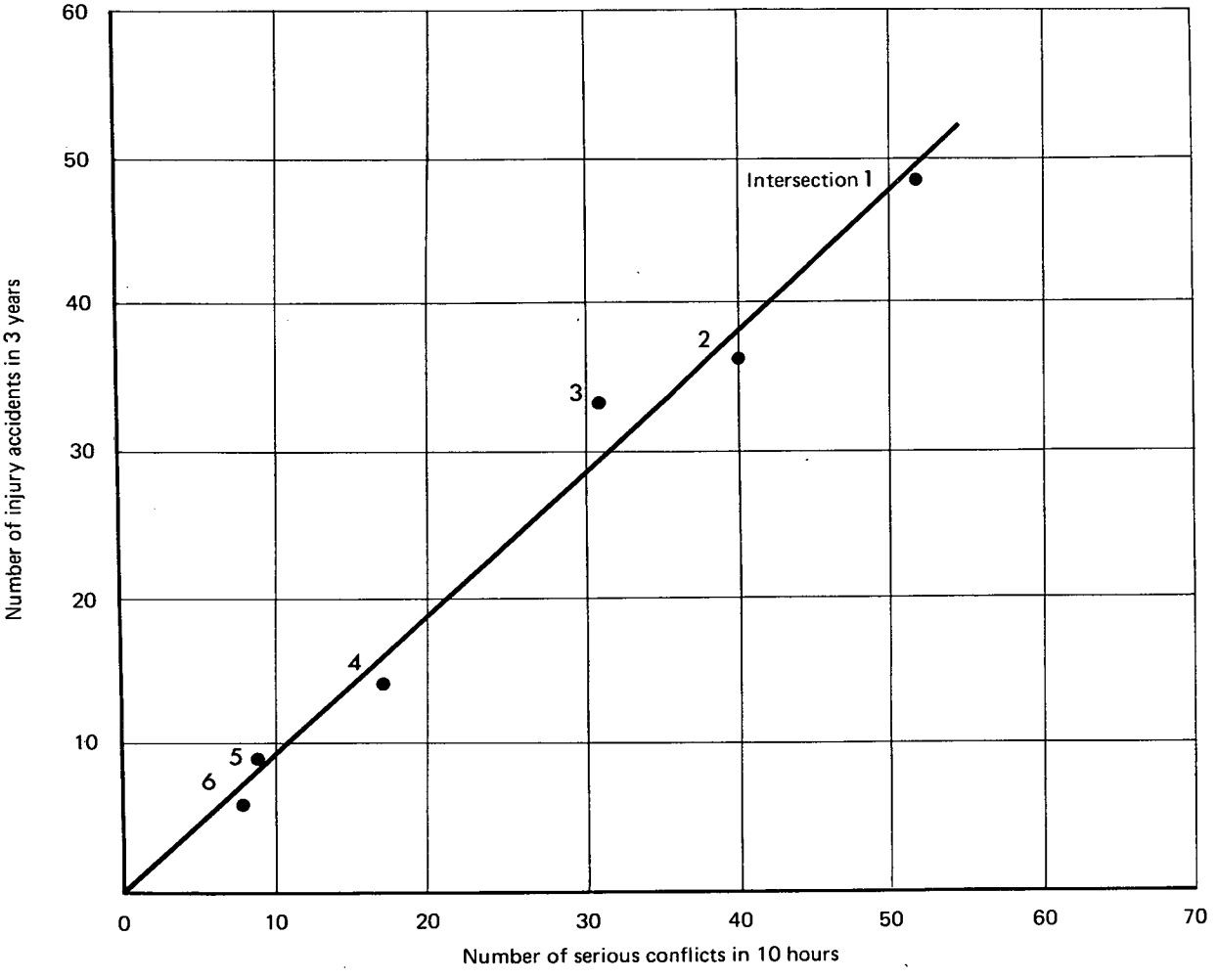
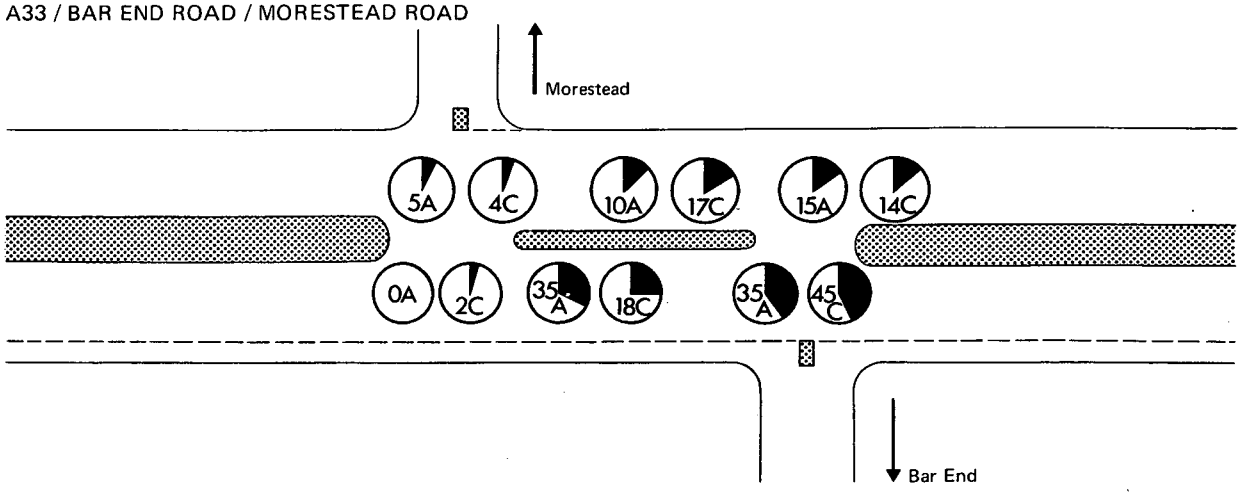


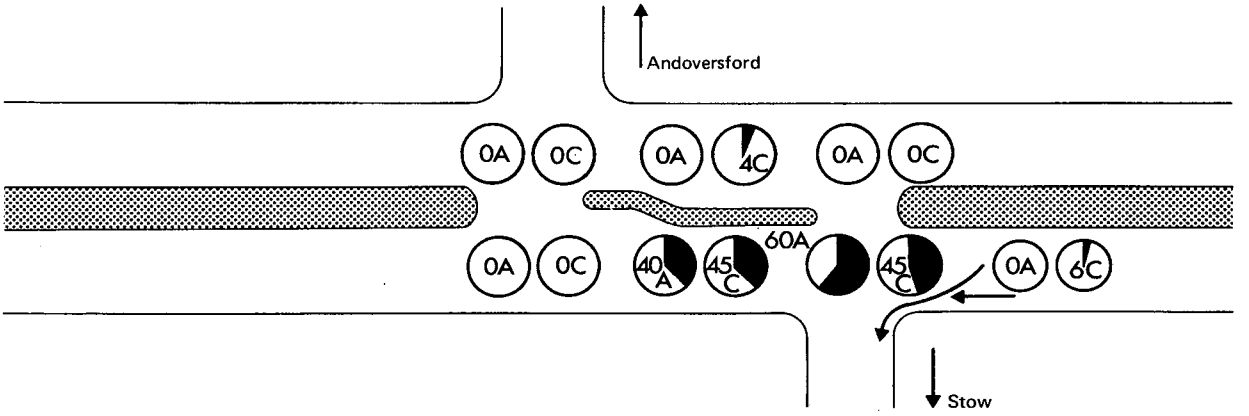
FIG 3 NUMBER OF INJURY ACCIDENTS AND SERIOUS CONFLICTS AT SIX INTERSECTIONS

All numbers given are percentages of total numbers of conflicts or accidents occurring at the junction.

A33 / BAR END ROAD / MORESTEAD ROAD



A40 / A436



FELTHAM ROAD/CLOCKHOUSE LANE/CONVENT ROAD

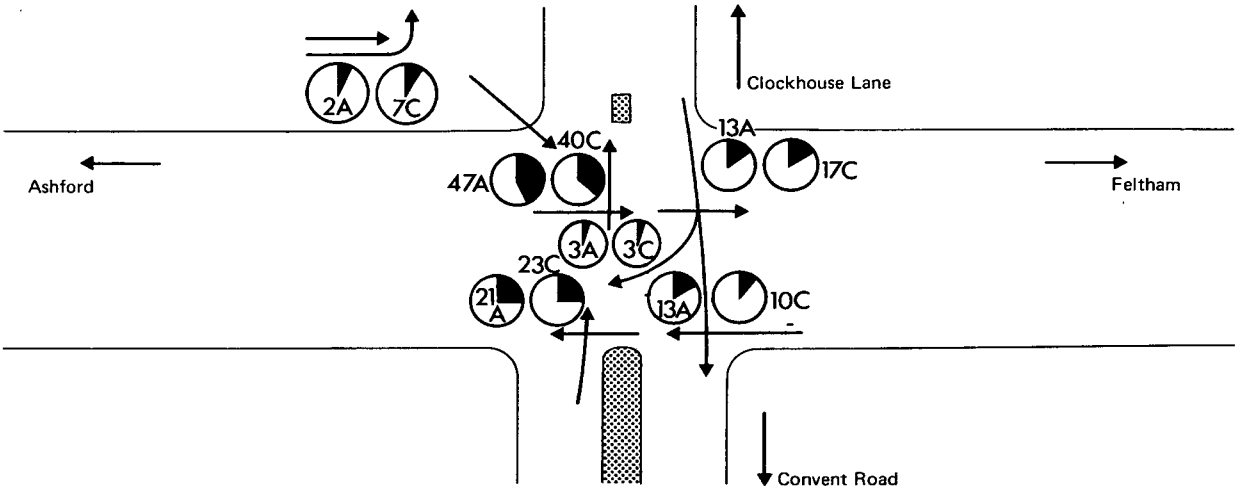


FIG.4 PLACE OF OCCURRENCE AND PERCENTAGES OF SERIOUS CONFLICTS AND ACCIDENTS

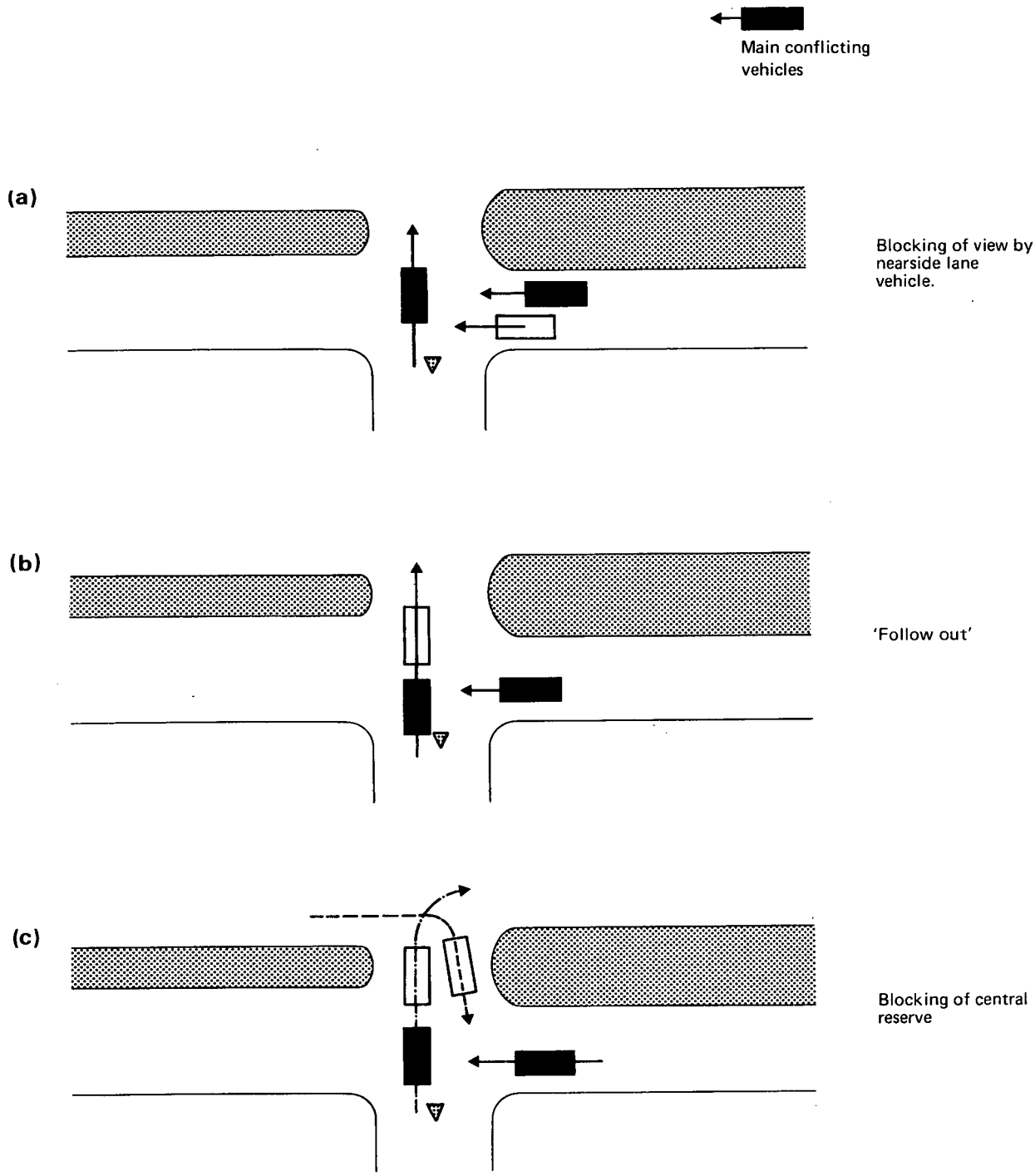


FIG 5 COMMON SITUATIONS OF MULTI-VEHICLE CONFLICTS AT DUAL CARRIAGEWAY INTERSECTIONS

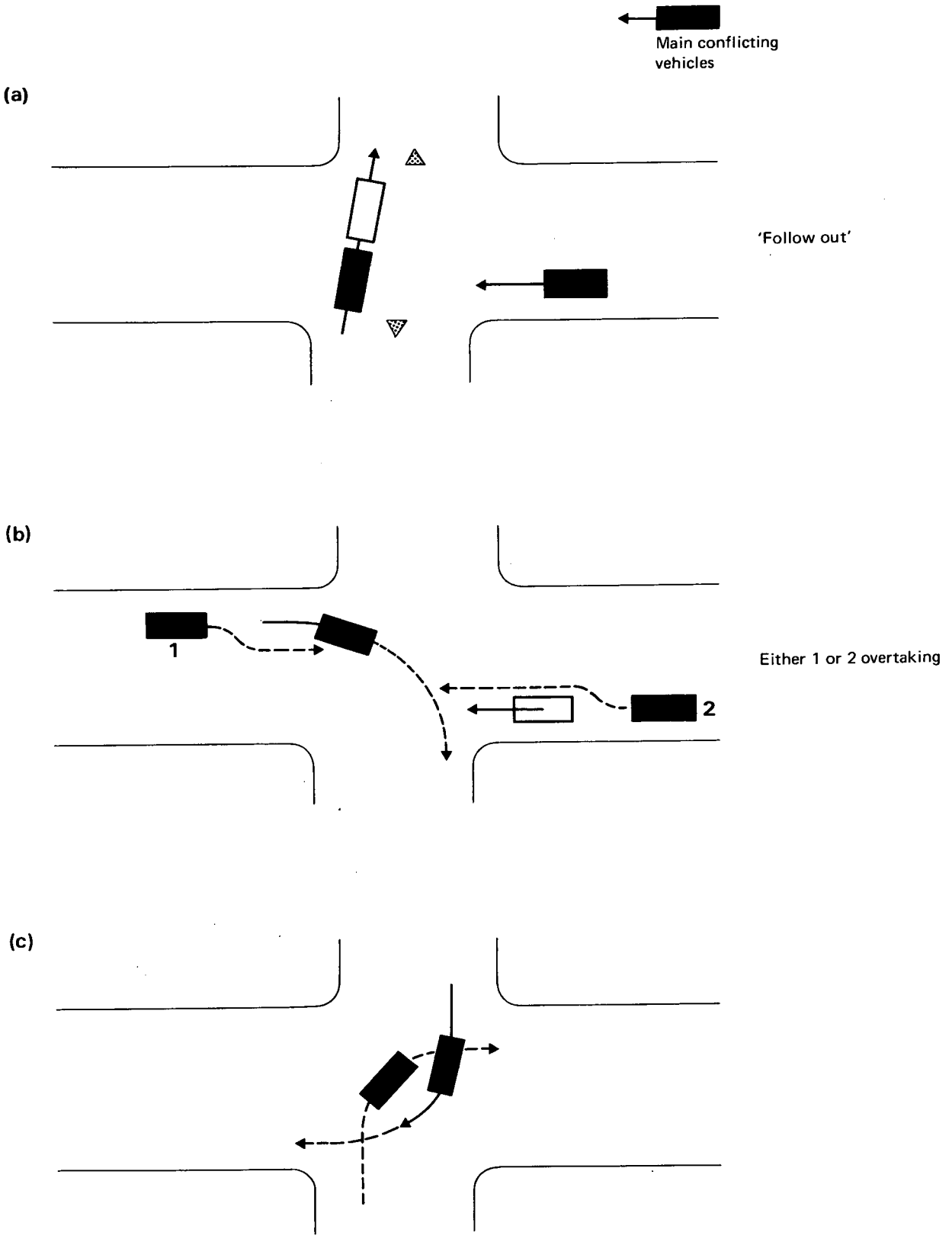


FIG 6 COMMON SITUATIONS OF MULTI-VEHICLE CONFLICTS AT SINGLE CARRIAGEWAY INTERSECTIONS

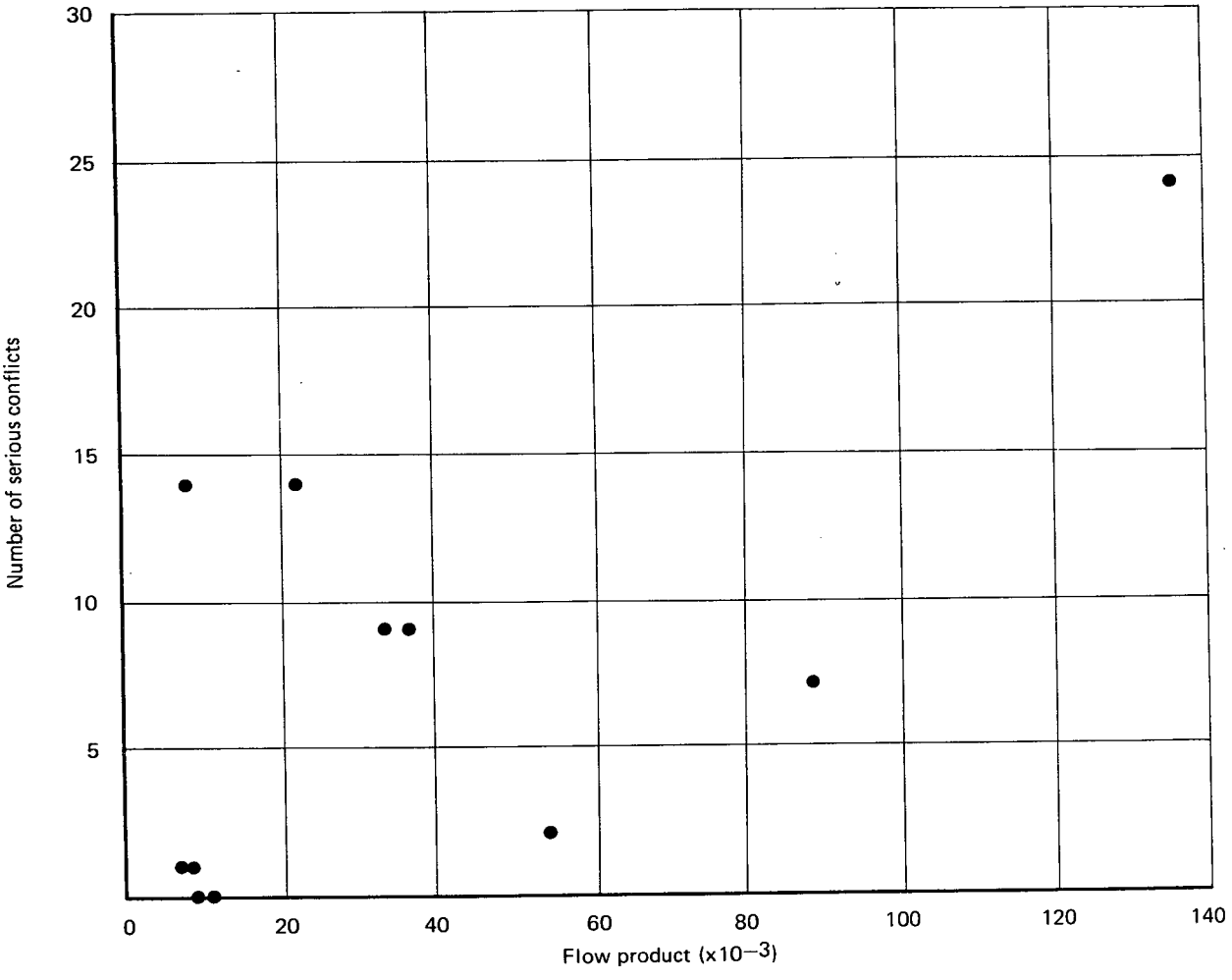


FIG 7 NUMBER OF SERIOUS CONFLICTS PLOTTED AGAINST THE PRODUCT OF CROSSING FLOWS FOR SIX CONFLICT GENERATING MANOEUVRES AT TWO DUAL CARRIAGEWAY INTERSECTIONS

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ABSTRACT

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