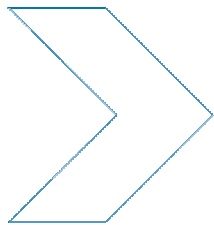


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Should U-turns be permitted at signalised intersections?

TP Hutchinson, JE Woolley

CASR REPORT SERIES

CASR017

June 2008



Report documentation

REPORT NO.	DATE	PAGES	ISBN	ISSN
CASR017	June 2008	17	978 1 920947 16 3	1449-2237

TITLE

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Centre for Automotive Safety Research
<http://casr.adelaide.edu.au/reports>

ABSTRACT

In South Australia, U-turns are not permitted at signalised intersections. The present report is a brief review of this topic. We have located no research that indicates that a "U-turn permitted" treatment would be irresponsible. However, our opinion is that a change to South Australian practice would have a degree of danger, because drivers here are accustomed to U-turns being prohibited at traffic signals, and sufficiently strong arguments in favour of permitting U-turns are not known to us. Note that the literature review component of this project was completed in 2005.

KEYWORDS

Turn, Signalised intersection, Traffic regulations

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Summary

In South Australia, U-turns are not permitted at signalised intersections. The present report is a brief review of this topic.

One of the main streams of thought identified is the promotion (under some such heading as “access management”) of a left turn on to a major road, followed by a U-turn, as being safer than a right turn on to the major road. The U-turn is envisaged as being usually made at a break in the median, not at a signalised intersection, but occasionally the U-turn would need to be made at a signalised intersection, and thus is relevant to the present report.

Traffic engineering practice in the different Australian States and overseas in respect of U-turns at signalised intersections is described.

We have located no research that indicates that a “U-turn permitted” treatment would be irresponsible. However, our opinion is that a change to South Australian practice would have a degree of danger, because drivers here are accustomed to U-turns being prohibited at traffic signals, and sufficiently strong arguments in favour of permitting U-turns are not known to us.

The literature review component of this project was completed in 2005.

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1 Introduction

In South Australia, requests are sometimes made (including from the Metropolitan Region of Transport SA) for U-turns to be permitted at signalised intersections. The Australian Road Rules (ARR) (NTC, 1999/2008) allow for this if a “U-turn permitted” sign is erected. But the responsible officers from Transport SA have not supported such requests because in each case a reasonable alternative was found, and U-turns are considered to be potentially risky at sites where there are generally many vehicles. In addition, allowing U-turns would probably involve changes to the signal times or sequence, which would affect all signals along the length of road and therefore traffic flow. The present report is a brief review of this topic.

There have been several papers in recent years that have promoted the idea of a left turn on to a major road, followed by a U-turn, as being safer than a right turn on to the major road. As the majority of these envisage the U-turn being made at a break in the median, not at a signalised intersection, they are for the most part outside the scope of this report. Nevertheless, some envisage the U-turn being made at a signalised intersection, and a number of the papers discussed in Section 2 come from this background. (Actually, many of these papers are from the U.S.A, and refer to right turn plus U-turn as an alternative to left turn.) Section 3 sets out the present position in South Australia, and Section 4 describes the position interstate and internationally. The report ends with a brief statement of conclusions in Section 5.

2 Recent research

The purpose of Section 2.1 will be to establish a structure for the description of recent research (mostly from the U.S.A.) that will be given in Section 2.2 and the discussion of it in Sections 2.3 and 2.4.

2.1 Setting the scene about the major issues

A U-turn needs to be performed at slow speeds, and the vehicle is travelling at an appreciably different speed to other traffic. It is an unusual manoeuvre, and may not be anticipated by traffic travelling straight on. Traffic turning left into the same carriageway as the U-turning vehicle, and pedestrians, may also be surprised and put at risk.

We assume that if permitting U-turns were under consideration at any particular intersection, considerable thought would be given to matters such as the road geometry, signal timings, and the needs of left-turning traffic and pedestrians.

Should U-turns be permitted at many signalised intersections?

As far as we know, no-one in South Australia is arguing for permitting U-turns at many signalised intersections. That is, there is no serious consideration being given to either (a) changing the default position to U-turns being permitted unless otherwise signed, or (b) using signs to permit U-turns at many signalised intersections.

Such a policy is not out of the question.

- As will be discussed in Section 4, the longstanding practice in Victoria differs from the rest of Australia: U-turns are permitted unless signed otherwise. Despite some wish for uniform national Road Rules, it seems unlikely that this provision will be changed in the foreseeable future (personal communication from Bruce Thompson, Road Safety Engineering, VicRoads).
- Some State highway authorities in the U.S.A. have regarded left turns at an unsignalised intersection into a major road (the equivalent of right turns when driving on the left) as a major safety problem. A strategy for treating this is to remove the opening in the median; therefore vehicles from the minor road are forced to turn right, and these subsequently make a U-turn. This is usually at an opening in the median, but it could be at a signalised intersection. For traffic driving on the left, this becomes a left turn from the minor road on to the major road, followed by a U-turn perhaps at an opening in the median but perhaps at a signalised intersection.
- Some sections of main arterial road in NSW have been treated similarly, with the U-turn manoeuvre facilitated with an opening in the median prior to signalised junctions (personal communication from Damien Chee and Bob O'Keefe, RTA).
- In Adelaide, there are many intersections where right turning vehicles can cross one carriageway and then wait at an angle in a short storage lane cut out of the median before joining the other carriageway. This can be a difficult manoeuvre, and there would be a case for redesigning such intersections even if the accident numbers were to show they are not particularly dangerous.

However, as mentioned, we think that such policies are not under consideration in South Australia, and that they are beyond the scope of the present report.

Should U-turns at signalised intersections ever be permitted?

Having dismissed permitting U-turns at *many* signalised intersections, what is under consideration is the use of "U-turn permitted" signs in fairly unusual circumstances.

The case in favour is that turning right into a busy major road is a difficult and dangerous manoeuvre. This can be eliminated by blocking any opening in the median. Traffic then makes a left turn on to the major road, followed by a U-turn. This may be safer than a right turn on to the major road, conceivably even if the U-turn were at an intersection rather than at a break in the median. Right turns *from* a major road can also be difficult and dangerous, and similarly can be replaced by a U-turn followed by a left turn. (It is immaterial here whether the access to/from the major road is for a minor road, a commercial property, or a residential property.)

General points in favour of sometimes making an exception would include the following.

- Any hard-and-fast rule is inflexible. One might accept that it is never a desirable option, but still consider that there may be locations where it is not worse than a conventional approach.
- There may be sites where it gives greater flexibility in traffic management.
- When making a decision, we must be careful to define the location under consideration appropriately. It is conceivable that greater safety elsewhere --- achieved by, for example, making right turns physically impossible --- might outweigh the dangers at a site where a U-turn is permitted.

The general case against making exceptions would include the following points.

- Drivers will not be expecting it --- their unfamiliarity with something unusual is a source of danger.
- If drivers can make a U-turn at one signalised intersection, they may think that they can do it at other places also.

The nature of the likely evidence about this

We might hope for some form of empirical or statistical evidence about the danger (or safety) of permitting U-turns. However, it seems unlikely that evidence will be either high in quality or great in quantity.

- High quality evidence would come from a randomised experiment in which some candidate intersections are assigned to the treatment condition (U-turns permitted) and others to the no treatment condition, and results (in terms of accidents and delays) compared. Hutchinson and Meier (2004) discussed the advantages of randomised experimentation. They also reviewed its applications in traffic engineering. None of the experiments related to U-turns at signalised intersections.
- Evidence from longitudinal (before-and-after) studies or from cross-sectional studies would have some value, but would be open to the objections that are routinely made against these methodologies. (For example, if a before-and-after comparison is made, other changes may have accompanied the change of interest; if a comparison of one group of intersections with another is made, the groups may differ in some other way besides the feature of interest.)
- As to quantity, what we have in mind are fairly unusual situations, and so the sample size for any straightforward comparison is likely to be tiny. And an attempt to extrapolate from normal behaviour in normal situations is likely to be unconvincing: exceptions do not necessarily follow the same trends as normal situations.

Thus it seems unlikely that evidence will be better than common sense or “engineering judgment”. There has, however, been a little relevant research, and this will be summarised below.

2.2 Recent literature

As mentioned earlier, there is some traffic engineering opinion that regards (for traffic driving on the left) a left turn on to a major road, followed by a U-turn, as safer than a direct right turn on to the major road. "Access management" is a phrase much used to describe such a strategy of treating intersections, and an example of a publication on this is the *Median Handbook* published by the Florida Department of Transportation. However, such work generally envisages most of the U-turns being made at a break in the median, not at an intersection, and thus is outside the scope of our discussion.

We have located three studies on U-turns at signalised intersections, and these will now be described. All these studies were conducted in the U.S.A., in the States of Kentucky, North Carolina, and Florida.

Kentucky

The research reviewed by Stamatiadis et al. (2004) largely concerns U-turns away from intersections. However, Section 3 of the report is useful as it deals with U-turns at signalised intersections. This may be summarised as follows.

- This paper refers to crash data on three stretches of road in Kentucky.
- In Somerset (26 intersections in 5.4 miles): there was a 16% reduction in total crashes, but there was a 19% increase in crashes at intersections; of those at intersections, U-turn crashes constituted approximately 1%.
- In Lexington (3 intersections in 1 mile): there was an increase in crashes, a decrease in crashes at intersections; of those at intersections, U-turn crashes again constituted approximately 1%.
- In Pikeville (7 signals in 2.1 miles): the change was too recent to permit comparison of after with before.

North Carolina

In North Carolina, Carter et al. (2005) studied crashes at 54 randomly-chosen sites and 24 selected as being U-turn problem sites. They find no great safety problems: "Although the group of study sites was purposely biased toward sites with high U-turn percentages, the study found that 65 of the 78 sites did not have any collisions involving U-turns in the three-year study period. U-turn collisions at the remaining 13 sites ranged from 0.33 to 3.0 collisions per year".

Florida

Research has been conducted in Florida by Lu and colleagues into right turns plus U-turns at signalised intersections. (Earlier, there was research into right turns plus U-turns at median openings.) In the two reports by Lu, Pirincioglu and Pernia (2005a, b), there were 16 signalised intersections. Because crashes are so infrequent, the number of crashes was not the quantity of interest in this programme of research, but the number of traffic conflicts (that is, incidents that nearly were crashes) was used instead. Video recordings were made, and subsequently examined in order to identify conflicts. Recordings were only made in normal (not congested) traffic conditions, good weather, dry road surface, and daylight. The conclusions of Lu and colleagues were favourable to right turns plus U-turns rather than direct left turns.

2.3 Discussion of crashes

It should be pointed out that much of the evidence in the Stamatiadis et al. and Carter et al. reports refers specifically to U-turn crashes. Two criticisms can be made.

- U-turn crashes may be poorly described by witnesses, or coded differently in the crash records. Vehicle movement and manoeuvre is a variable that is often unreliable in crash databases (Hutchinson, 1987, especially Chapter 4).
- Total crashes is the statistic of chief interest --- it is conceivable that making provision for U-turns changes traffic patterns in some way (more congestion, perhaps) that leads to more crashes of other types.

Nevertheless, we have no reason to consider these issues are of major importance --- we presume they occurred to Stamatiadis et al. and Carter et al., and were dismissed.

Concerning the research by Lu and colleagues, we do not disagree with the choice of methods or with the conclusions, but others may do so: it is possible that traffic conflicts do not reflect crashes, or crashes in a subset of conditions do not reflect total crashes.

We should also call attention to the following.

- *Richmond, British Columbia.* U-turns at six intersections became permissible (in 2001) when a median busway was built. (See <http://www.richmond.ca/services/ttp/traffic/uturns.htm>.) We are not aware of a formal report on the subsequent crash experience, but we understand that there is no safety problem.
- *Oregon.* A study has been made of the feasibility of increasing the number of signalised intersections where U-turns are permitted, and a report is in preparation; no relevant crash data from elsewhere was found in the course of this study. (See <http://www.odot.state.or.us/traffic/OTCDC/12-16-2004%20OTCDC%20Minutes.doc>.)

2.4 Discussion of traffic flow

There are several ways in which permitting U-turns might affect traffic, such as:

- A direct effect on traffic from a different balance between the several flows at the intersection itself,
- An effect on traffic from changes in the total flow (e.g., an increase as a result of elimination of right turns nearby), and
- A narrowly-defined effect on traffic through a vehicle making a U-turn rather than doing something else.

These effects seem likely to be small. Even so, we consider that if serious consideration were being given to permitting U-turns at a particular intersection, the effect on appropriate signal phasing should be one of the factors examined.

Nothing general can be said about the first two classes of effect --- for any particular intersection, the traffic flows would need to be measured, appropriate signal settings calculated, and delays estimated. For given geometric and traffic conditions, simulation is one of the available tools for estimating travel times under different access management strategies (Chowdhury et al., 2005). The third of the above classes of effect has attracted some attention in the literature. This has taken the form of research into the effect on saturation flow of vehicles making U-turns. As might be expected, saturation flow is reduced a little below what it would be if the vehicles were turning right. For more on this, see Adams and Hummer (1993), Tsao and Chu (1995), Carter et al. (2005), Lu and Liu (2005), and Lu, Liu, Fan, and Pernia (2005).

It seems probable to us that consideration would only be given to permitting U-turns at an intersection where there was already a right-turn phase, and therefore changes to the signal settings would be fairly minor. However, if that were not the case, then quite a substantial redesign of the settings might be needed.

We recommend that if serious consideration were ever given to permitting U-turns at a particular intersection, traffic flows should be measured and estimates made as to what the traffic flows would be if the change were made and what the consequences would be for vehicle delays. It is unlikely that traffic reasons would be decisive in prohibiting U-turns.

3 The present position in South Australia

3.1 U-turns other than at signalised intersections

Except at signalised intersections, U-turns are permissible — provided, of course, that conditions are safe. There is a section in *The Driver's Handbook* (DTEI, 2005) that sets out how a U-turn should be made and the circumstances in which it is illegal.

3.2 U-turns at signalised intersections

Concerning signalised intersections, the following is from *The Driver's Handbook* (p. 54 of 2005 printing): “You must not make a U-turn at an intersection with traffic lights unless there is a U-turn Permitted sign”. This wording implies that a “U-turn permitted” sign may be used. However, as mentioned in the Introduction, Transport SA does not support the use of such signs. There are two places (one eastbound and one westbound) where tram tracks have recently been laid on North Terrace, Adelaide, where U-turns are permitted on a green arrow signal. Also, there is an exception implemented by the Adelaide City Council on King William Road, Adelaide, at the intersection with Victoria Drive, where a bus-only signal permits buses to U-turn from a dedicated kerbside bus lane under a separate signal phase. Otherwise, we are not aware of any being installed in South Australia.

There is no national policy that would prevent installation of a “U-turn permitted” sign.

- The Australian Road Rules envisage the use of “U-turn permitted” signs. They state, “A driver must not make a U-turn at an intersection with traffic lights unless there is a U-turn permitted sign at the intersection”, and the design of the sign is illustrated in Figure 1.
- The *Australian Standard Manual of Uniform Control Devices* (Part 2, p. 18) gives some advice on the appropriate use of “U-turn permitted” signs.
- Indeed, U-turns are permitted at a small number of sites in all other States and Territories that use “U-turn permitted” signs (see Section 4 below).



Figure 1
U-Turn Permitted sign as outlined in the Australian Road Rules

3.3 Other issues

We do not know of evidence one way or the other about whether, if “U-turn permitted” signs were used at a few signalised intersections, many South Australian drivers would perform the manoeuvre at other intersections also. In addition, the following issues are considered beyond the scope of the present report: enforcement of the prohibition at signalised intersections; policy in Victoria (where the default position is that U-turns are permitted at signalised intersections, see Section 4 below); and whether most drivers who offend in this way are visitors from Victoria.

4 What is done interstate and internationally?

Telephone discussions were held with personnel from all State and Territory road authorities. With the exception of Victoria, the standing policy is not to allow U-turns at many signalised intersections. U-turns are only permitted in circumstances of a strong public demand for the manoeuvre, a suitable road geometry, and a dedicated right turn phase (or in some rare cases a dedicated U-turn phase as shown in Figure 2). There is some discussion of the development of the Australian Road Rules by Jordan (1995) (but Jordan was with VicRoads, the odd-man-out in respect of this issue).



Figure 2
Example of U-turn signal phasing in use in Melbourne
(photo courtesy of Akcelik and Associates, Melbourne)

An issue raised by many States is the danger posed by the presence of a traffic splitter island for left turning vehicles on an adjacent road (see Figure 3). Western Australia overcomes this problem by not permitting U-turns if there are any conflicting manoeuvres.

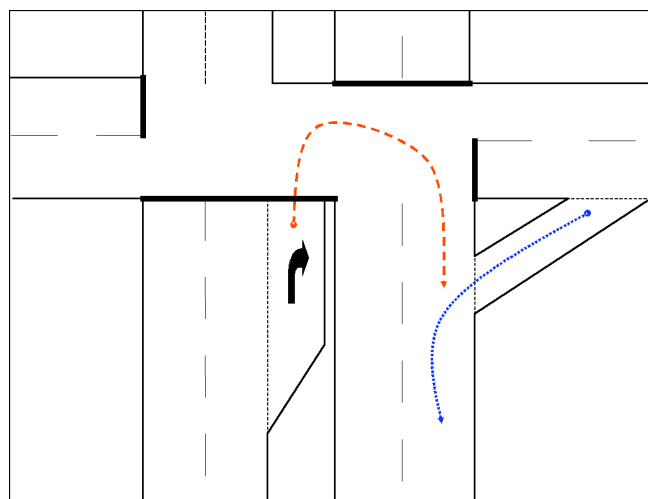


Figure 3
Conflict between a U-turning vehicle and a left turning vehicle directed by a splitter island

Table 1 summarises the situation in each State and Territory. No knowledge of evaluations was possessed by any of the jurisdictions. Only WA and Queensland have detailed guidelines — the other States leaving assessment to the discretion of traffic engineers.

Table 1
Summary of U-turn practices at signalised intersections in Australia

Jurisdiction	Default Position	Prevalence	Comments
SA	Banned unless ARR sign displayed	2/700 signalised intersections	See Section 3.2
NSW	Banned unless ARR sign displayed	None	U-turns prohibited by RTA guidelines
Queensland	Banned unless ARR sign displayed	<5% of signalized intersections	Guidelines exist
WA	Banned unless ARR sign displayed	8/800 signalised intersections	Guidelines exist
Tasmania	Banned unless modified ARR sign displayed	20/250 signalised intersections	
ACT	Banned unless ARR sign displayed	10% of signalised intersections	Prior to 1999 U-turns were allowed by default
NT	Banned unless ARR sign displayed	5/80 signalised intersections	
Victoria	Allowed unless U-turn not permitted sign displayed	Unknown how many sites ban U-turns	Use of ARR sign permitting U-turns is prohibited in Vicroads guidelines

South Australia. While there is provision for the use of the “U-turn permitted” sign under the ARR, Transport SA does not usually support its use. See Section 3.2 for discussion of special treatment of U-turning at three places.

N.S.W. The Road Safety and Traffic Management Directorate of the Roads and Traffic Authority issued *Technical Direction 99/23* on 15th October 1999. This looks forward to the adoption on 1st December 1999 in New South Wales of the ARR (which, as noted above, include a “U-turn permitted” sign). The Technical Direction prohibits the use of “U-turn permitted” signs, thus continuing the previous prohibition of U-turns at traffic signals. The main reason for this policy was the lack of a satisfactory method for evaluating the effect on safety of permitting U-turns at any specific signalised junction. The few U-turns that have been implemented involve diversion of the U-turning vehicles into parallel service roads for eventual merging back into the main traffic stream. The U-turn manoeuvre itself is made in an opening in the median prior to the signalised junction.

Queensland. The *Traffic and Road Use Management Manual* includes a guideline that permits installation of “U-turn permitted” signs. There are quite detailed requirements. It is expected that there will be a special right turn phase.

Western Australia. In *Document 67-08-1*, Main Roads Western Australia sets out a policy that permits installation of “U-turn permitted” signs. There are quite detailed requirements. It is expected that there will be a right turn phase with no conflicting manoeuvres.

Tasmania. Tasmania generally does not permit U-turns at signalised intersections unless there is strong public demand for the manoeuvre. Whether a site is suitable or not is left to the discretion of a traffic engineer. Heavy vehicles are discouraged from performing U-turns and the standard ARR sign is modified to include the words “light vehicles only” (see Figure 4).

Australian Capital Territory. Prior to 1999, U-turns were permitted by default in the ACT. However with the adoption of the ARR in 1999, U-turns were banned unless signed otherwise. A major arterial in the ACT permits U-turns at most of its signalised intersections, the rationale being to permit access to residential properties on the midblock sections. No changes in crash patterns have been noticed since 1999.



Figure 4
U-Turn Permitted sign as used in Tasmania

Northern Territory. The Northern Territory Traffic Code Book advises drivers that “U turns should not be made at or near traffic lights”. A special U-turn phase exists at one signalised intersection and 4 of 80 signalised intersections have the ARR U-turn permitted sign.

Victoria. Vicroads’ *Traffic Engineering Manual* (Volume 2, Section 8.5.5) states that the “U-turn permitted” sign is not to be used in Victoria. By default, U-turns are permitted unless signed otherwise, and it seems to be thought preferable they be made at signalised intersections. This position is presently not under review. It is not known how many U-turn prohibited signs exist but it is thought that their use is rather scarce. According to Jordan (1995), “Is making a U-turn at a set of traffic signals unsafe? Not according to Victorian experience — the issue is a non-issue!”

New Zealand. The default position in New Zealand is apparently that U-turns at signals are permitted (but some local authorities have banned them at some intersections).

North America. Our understanding is that, as in Australia, States of the U.S.A. and Provinces of Canada differ from each other. (In addition, cities and counties within States may differ from the State norm.) For example, the default position in California is that U-turns at signals are permitted, and in Prince Edward Island U-turns at signals are not permitted.

5 Conclusion

The choice between:

- A blanket prohibition of “U-turn permitted” signs, and
- Their occasional use where no better alternative can be devised (as in the other jurisdictions),

is not an easy one. It is not of the highest importance, either, in the sense that only very few intersections would ever be serious candidates for a “U-turn permitted” treatment.

Our view is as follows:

1. We have located no research that indicates that a “U-turn permitted” treatment would be irresponsible.
2. However, our opinion is that to allow U-turns at signalised intersections (i.e., a change to South Australian practice) would have a degree of danger, because drivers here are accustomed to U-turns being prohibited at traffic signals, and sufficiently strong arguments in favour of permitting U-turns are not known to us. We therefore recommend retaining the present policy of not permitting U-turns at signalised intersections.
3. Right turns into major roads can be reduced by blocking as many median openings as feasible. If such a strategy were ever to be considered on a large scale for Adelaide, permitting U-turns at signalised intersections should not be ruled out as a complementary measure.

Acknowledgements

The authors thank staff of Australian State and Territory Road authorities who contributed to discussions on the issue, and several overseas correspondents.

This study was funded by the South Australian Department of Transport, Energy and Infrastructure (DTEI) through a Project Grant to the Centre for Automotive Safety Research. The DTEI Project Manager was Peter Tan.

The Centre for Automotive Safety Research receives core funding from both DTEI and the South Australian Motor Accident Commission.

The views expressed in this report are those of the authors and do not necessarily represent those of the University of Adelaide or the sponsoring organisations.

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