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SERVICE AND REST AREAS IN TOLL MOTORWAYS IN POLAND: STUDY OF DISTRIBUTION AND FACILITIES

Summary. Service areas are places next to the road that provide services to motorists like petrol stations, restaurants, hotels, etc. Rest areas are zones near the road with a parking and some facilities, such as toilets and picnic areas, which are employed by road users during their travels. These areas play a vital role in road safety as they are demonstrated to reduce fatigue-related accidents. Moreover, in toll motorways, usually used for long-distance travels, these areas become essential as they are the only place to have rest or access to services as leaving and returning to it in the same point implies additional costs. This fact was verified by a survey conducted to 124 motorists who indicated that, if it is not totally necessary or they have not planned it in advance, they would not leave the freeway. The aim of this paper is to analyze the facilities offered in rest and service areas and the distances between them in the paying motorway network of Poland. Average distance between service areas and any type of areas are reasonable. The minimum distance established in Polish law is fulfilled in all the motorways, except a stretch in the A-1. All the rest areas include toilets and all the service areas include petrol, shop, toilets and a café. Other facilities are not so frequently available. The maximum distances between areas are over recommendations from other countries, and hence, a limit is recommended to improve road safety in Poland.

1. INTRODUCTION

For decades, road transport has become the most widely used transport mode for both passenger and freight transport in Europe [1] and the same situation is seen in Poland [2]. Furthermore, the most important roads of any country, generally consisting of freeways or motorways, have the main part of the national traffic, around half of all the traffic, including the light and heavy ones [3, 4].

Due to the importance of highways, administrations (national, regional, or local) must maintain their road network in good conditions to provide a safe and comfortable infrastructure to the users. On one hand, road pavement must be maintained in serviceable conditions, roughness controlled and skid resistant, generally by means of pavement management systems [5-11]. On the other hand, safety measures must be incorporated in the road design, and road elements should provide safe conditions to the users [3, 12]. One of these road elements aimed to improve safer conditions are service and rest areas. Service areas are generally defined as areas close to the road specifically designed to host facilities for road users' needs, like petrol stations, restaurants, hotels, garages and other services related to the safety and comfort of motorists. Rest areas are usually defined as places beside the road with an area for parking, for cars, trucks and caravans, and sometimes, facilities for road users to have rest in their travels, outside the carriageway [13, 14]. The main difference between the two types of areas relies on the presence of a petrol station, a facility closely related to road transport. When a petrol station is available in a service area, other types of services appear like cafés, restaurants, shops

and even hotels and garages (Fig. 1). On the other hand, in rest areas, gas stations are not present, and very few commercial facilities are available in these areas, usually reserved for parking, toilets, relaxing or having lunch/dinner (Fig. 2).



Fig. 1. Examples of service area: a) a service area with a petrol station and a restaurant in France and b) a petrol station in a service area in Spain



Fig. 2. Examples of rest areas: a) rest areas with restrooms, picnic area and playing area for children in France and b) rest area with only some benches in Spain

Hence, the main objective of rest and service areas is to be employed as a place to rest, relax or even check for the requirement of anything in the vehicle. Toilets in these places are frequently used by motorists. Having something to eat or drink or just resting is also common in these areas. Moreover, having a picnic, buying something at a shop, having lunch or dinner at a restaurant, changing the driver, getting some tourist information or sleeping are other possibilities that can be carried out in rest and service areas [14].

Due to their importance, service and rest areas must be properly distributed along the itineraries. They would be useless for road users if they were not distributed in an adequate frequency. Moreover, the facilities available in each area and a good maintenance are other key points that must be verified.

Furthermore, the presence of these areas is even more decisive in toll motorways. Motorways connect cities, which can be reached for some facilities. Nevertheless, in toll motorways, paying motorways or freeways, using these facilities would imply an extra cost, and hence, users only use available facilities inside the freeway.

In toll motorways, service and rest areas are normally accessed by independent exit lanes, separated from junction, in order not to confuse drivers. These areas are provided with enough distance and enough time to get informed all the users. Moreover, available services are normally also displayed, even the prices of the fuels in the case of service areas.

With regard to the convenient distance between these areas some research can be found in the literature. It was demonstrated that accidents related to fatigue decreased in the zones after the establishment of rest areas compared to accidents related to other factors [13]. Moreover, cases of accidents caused by fatigue reduce in the area around rest areas and increase considerably after 30 miles (48.28 km), whereas accidents that are not caused by fatigue maintain a constant rate [13]. Furthermore, McArthur et al. [15] established an area of 20 miles (32.18 km) from these areas where accidents due to fatigue were reduced. Finally, from the economical point of view, it was concluded

that rest areas of the paying motorways of Michigan (USA) had a benefit/cost ratio of 3.36 and 4.00 for standard areas and for areas with tourist information, respectively [14]. The benefits introduced in the analysis were travel diversion savings, accident reduction, comfort and convenience benefits, and the costs were construction, rehabilitation and maintenance of these areas.

The paper aims to study the spatial distribution of the rest and service areas on the toll motorways in Poland and the facilities that can be found in them, analyzing the distance for each service. The paper is organized as follows. Laws about rest and service areas in Poland are commented in Section 2. Section 3 describes the methodology deployed. In Section 4, results are presented and discussed. Finally, conclusions are exposed in Section 5.

2. POLISH LAWS AND RULES ABOUT SERVICE AND REST AREAS

Poland had a total road network, including all categories, of 419.600 km in 2015, of which paved roads represented the 69%. The length of the freeways was 1.634 km at the end of 2016, which means 5 km of motorways per 1000 km² of area of Poland and 4 km per 100 thousand inhabitants [2]. These figures do not vary much from other countries in the EU, where the average values in 2013 were 17 km and 15 km [1]. Out of the 1634 km of freeways, 861.9 km are toll freeways [2].

Nowadays, the regulation for rest and service areas in Poland is Dz.U.2016.0.124 t.j. [16]. There the main aspects of maximum and minimum distance and facilities that should be included are indicated. With regard to the distances, the following points are specified:

- In motorways, the minimum distance between two consecutive areas (rest or service areas) should be at least 15 km and the minimum distance from an area to the country border should be 3 km.
- In expressways, the minimum distance between two consecutive areas (rest or service areas) should be at least 10 km and the minimum distance from an area to the country border should be 1.5 km.
- During the reconstruction or renovation of the existing road, in the case of the existence of areas, the abovementioned distances can be reduced by 50%.

As observed, Polish rules do not indicate the maximum distance between areas but the minimum distance. This is established as a way to maintain a competence between service areas, not allowing, for example, several petrol stations being located very near between them. Thus, each facility has an influence area where they have no competence. ****Nonetheless, the absence of a maximum distance between areas implies that they can be far away from each other, and road users could not arrive to them on time.

Regarding the facilities, these types of rest areas are established [16]:

- Type I, with a rest function. They must be equipped with parking spaces, manoeuvring routes, rest facilities, sanitary facilities and lighting. It is allowed to be equipped with small catering facilities.
- Type II, with a rest and service function. They must be equipped with facilities referred to in type I and a petrol station, vehicle parking, restaurant and commercial facilities and tourist information.
- Type III, with a rest and service function. They must be equipped with facilities indicated in type II as well as accommodation facilities, and, additionally, depending on the needs, post office, bank, tourist office and insurance office.

As seen, and according to the definitions provided in Section 1, areas called Type I in Polish regulation could be classified as rest area, as they do not have a petrol station. Their aim is to provide a relaxing area to motorist and compulsory facilities are a parking area, restrooms, and lighting. A café is optional. Areas referred as Type II can be identified as service areas as they include a petrol station. Additionally, they also have a restaurant, a shop and some tourist information. Finally, areas of type III are higher level service areas that incorporate additional facilities such as hotels or motels, and

eventually, post office, bank, tourist office and insurance office. Hence, areas of type II and III are both considered as service areas.

3. METHODOLOGY

The methodology for analyzing the distances between the rest and service areas in toll freeways considers this road as a “*tunnel*” due to the fact that motorists usually do not leave the infrastructure until they reach their destination. Generally, if exiting a toll motorway in an intermediate point and coming back at the same point, a greater quantity of money must be paid than if all the travel is carried out without exiting the freeway. The reason is that prices are not proportional to the distance travelled and frequently there is a minimum charge for using the infrastructure.

In order to verify these assumptions, a survey was conducted in a toll motorway to 124 motorists in Spain. Drivers were asked about the reasons to leave a paying motorway. More than three quarters (77.4%) would abandon the infrastructure for reaching a garage to repair a light damage in the vehicle, but 79.2% of them said that they would not go to a hotel outside the toll motorway unless they have it planned it in advance. However, when the reason of leaving the paying freeway is a petrol station or a restaurant, less than the 5% of them would do it. Hence, motorists do not abandon the toll motorway unless they have it planned or there is a big problem in the vehicle. Otherwise, they continued their route and they only used service and rest areas when they found them. Consequently, a paying freeway can be considered as a tunnel, which cannot be left.

Furthermore, as motorways are normally fenced, drivers cannot access to adjacent areas in the case of an emergency situation, as they could do (usually) in a two-lane road, and they should park in the shoulders, which could be dangerous due to the high speed of other vehicles in the carriageway.

Taking the previous idea into account, the study of each Polish motorway was performed analyzing the entire paying distance, from the first entering point to the last exit where a toll is placed. Adopted methodology is explained with an example. A motorway with a length of 200 km is considered, where the initial point is placed in the marker post 0 and the final point in the marker post 200. Existing rest and service areas in the freeway, the kilometre where they are located and the facilities in them are shown in Table 1.

Table 1

Service and rest areas and their facilities in an example toll motorway

	Start point	Rest area	Service area	Service area	Rest area	Final point
Marker post (kilometre)	0	25	70	125	165	200
		Restrooms, Picnic area	Petrol station, restrooms, shop, and picnic area	Petrol station, shop, hotel, restrooms, picnic area, and restaurant	Picnic area	

With information from Table 1, some values can be deduced. For instance, the distances between service areas are 70 km (from the initial point to the first service area), 55 km (from the first one to the second one), and 75 km (from the second one to the finish point of the infrastructure). It is considered that the entire distance of the freeway is travelled. Therefore, the average distance between service areas, $D_{av, service\ area}$, is

$$D_{av, service\ area} = \frac{70 + 55 + 75}{3} = 66.66\ km \quad (1)$$

As observed, the average distance between any kind of area or facility can be obtained from the total distance of the considered motorway and the number of each area or facility, by means of Eq. (2):

$$D_{av,i} = \frac{L}{N_i + 1} \quad (2)$$

where $D_{av,i}$ is the average distance between facility i in a freeway in a direction, L is the total length of the stretch considered and N_i is the number of times that analyzed facility i is available. Average distances for the rest of facilities of the example of Table 1 are displayed in Table 2.

Table 2
Average distances and minimum and maximum distances between facilities/services and areas, in km, in the example stretch of Table 1

Facilities/services or areas	Minimum distance between facilities or areas (km)	Average distance between facilities or areas (km)	Maximum distances between facilities or areas (km)
Service areas	55	66.66	75
Area (service or rest area)	25	40	55
Restrooms	25	50	75
Picnic area	25	40	55
Petrol station	55	66.66	75
Shop	55	66.66	75
Restaurant	75	100	125
Hotel	75	100	125

Furthermore, another vital parameter is the maximum distance between any services or between areas. This value does not depend on the amount of those facilities or services but on how they are distributed along the freeway. For example, a service could be displayed in the freeway with an adequate average distance due to an optimum number of points where it is available. However, a long maximum distance could be critical for users, and accidents related to fatigue can appear. Arriving to some facilities can be programmed, such as restaurants and hotels, but others, like toilets, cannot be anticipated.

The analysis is performed in each of the directions of the motorway. For example, data from Table 1 refer to one direction. A similar study is carried out in the other direction. Values would be similar if similar areas with same services are located one in front of the other. If not, values would be different.

Lastly, it must be pointed out that service areas are considered independently and the term “*areas*” refers to both service and rest areas as they imply a place outside the carriageway where motorists can rest, although fewer services are available. They are a place to park apart from the shoulder.

4. RESULTS AND DISCUSSION

Table 3 and Fig. 3 show all the toll motorways in Poland, which were analyzed according to the methodology exposed in Section 3. A total of 861.90 km of double carriageway road was studied.

All the three motorways have some type of area, with some kind of facilities. The average distance, the average maximum distance and the minimum and maximum distance between facilities or areas in the Polish network are given in Table 4.

Table 3
List of Polish toll motorways analyzed and their length

Code	Itinerary	Length of the motorway (km)
A-1	GDANSK – TORUN	143,70
A-2	SWIELCKO – WARSAW	475,00
A-4	WROKLAW – KRAKOW	243,20
	Total	861,90



Fig. 3. Polish toll motorways network

Table 4

Average distance, average maximum distance and maximum and minimum distance between facilities or area in the Polish toll motorway network, in km

	Average distance (km)	Average maximum distance (km)	Minimum distance in the network (km)	Maximum distance in the network (km)
Area (service and rest area)	19.70	40.68	1.00	49.00
Service areas	40.49	63.54	25.00	80.30
Toilets	19.70	40.68	1.00	49.00
Restaurant	72.43	89.83	25.00	143.7
Café	30.51	54.18	9.45	80.3
Picnic area	20.62	40.68	1.00	49.0
Playing area for children	30.60	64.06	1.00	107.20
Shop	40.49	63.54	25.00	80.30
Petrol station	40.49	63.54	25.00	80.30

The average distance between every type of area, denominated as “area”, is 19.70 km and the average maximum distance between areas is 40.68. This value can be regarded as high. Moreover, the longest stretch without any type of area is placed in the A-2 motorway, between Baranow and the final part of the infrastructure, in Warsaw, with a distance of 49 km. It implies that during 49 km there is no possibility of stopping the vehicle outside the shoulders. On the contrary, maximum distances between areas in the other two motorways are below 40 km, but over 35 km (Fig. 4).

When analyzing the minimum distances between areas, distances from the initial point to the first area and from the last one to the finishing point have not been considered, as sometimes they are at a distance below 10 km. For some areas and for some facilities, minimum distances are below the established minimum distance of 15 km [16]. Facilities with a minimum distance between them below 15 km are those which do not imply competence, such as toilets, picnic areas or playing spaces for kids. However, there is an exception in the A-1 motorway, where two café are placed with a distance below 10 km in each direction, 9.45 and 9.95 km.

With regard to the service areas, the average distance between them is 40.49 km and the average maximum distance is 63.54 km. Fig. 5 shows the average distance and maximum distance between service areas in each Polish toll motorway. As previously commented, there is no limit range for

maximum distances in Poland. As an example, in Spain, it is established that the maximum distance between service areas should be between 40 and 60 km [17]. Thus, following Spanish regulations, only 1 of the Polish motorways would fulfil this requirement (Fig. 5). A limit is suggested for Polish network. A distance over 60 km between service areas means that a petrol indicator must be regarded before passing the area. Therefore, a modification in Polish regulations about these areas is recommended.

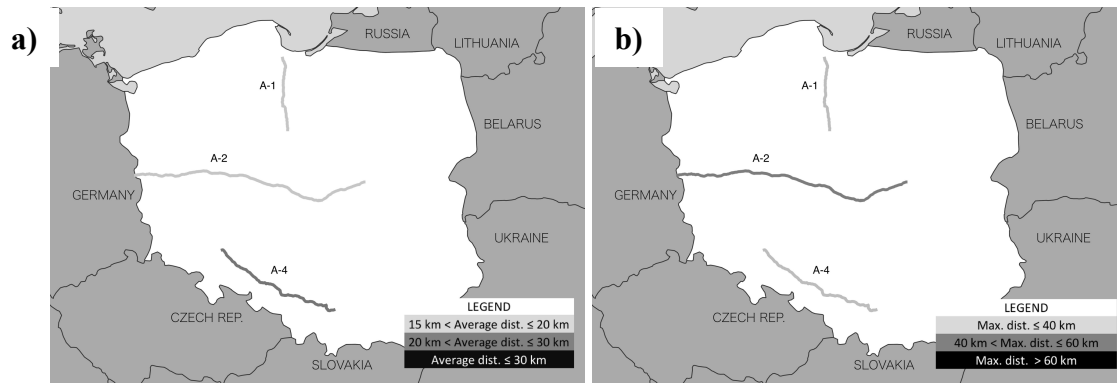


Fig. 4. a) Average distance and b) maximum distance between areas in each toll motorway in Poland

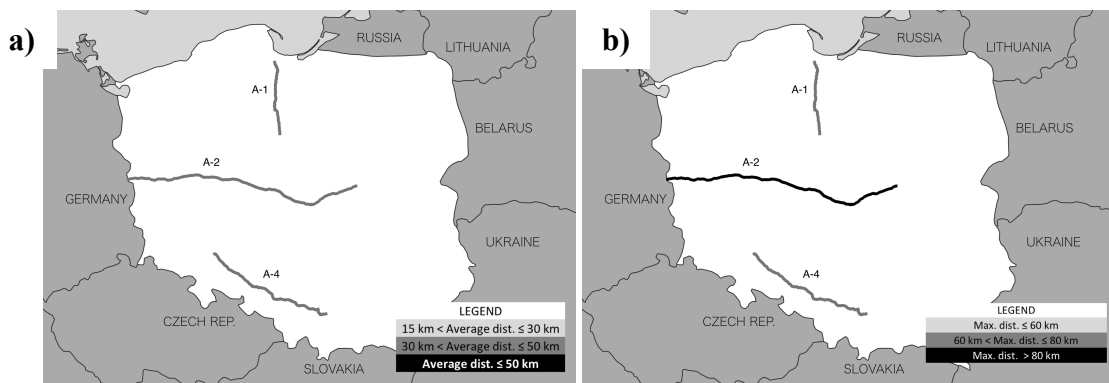


Fig. 5. a) Average distance and b) maximum distance between service areas in each Polish toll motorway

As seen in Table 3, the average distances for service areas, petrol stations and shops are identical because a service area is defined when petrol and shop is available, following the definition of Type II of area [16]. However, restaurants have greater values for all the distances as it is not a facility usually displayed in service areas. Fig. 6 shows the percentage of the service areas that have each service. As commented, petrol stations and shops are available in all the service areas, as well as cafés and picnic areas. Playing areas for children and restaurants can be found in almost all of them, 94.74% and 89.47%.

Nonetheless, other services are less frequently available in Polish service areas. Hotels are not so usual in paying freeways but achieve a rate of 26.32%. Showers, which can be useful for some motorists, mainly lorry drivers, are offered in 12 of the 38 service areas (31.58%). Additionally, no area for auto caravans, garage or leisure areas with activities can be found in Polish toll motorway network.

Lastly, Table 4 also indicates that values for rest areas and toilets are identical, as the Polish regulation [16] establishes that all areas (from Type I to III) must include restroom services, and hence, all rest areas have toilets (Fig. 7). This point is a key factor to provide a minimum service in any area. On the contrary, café, which is mentioned as an optional service, is only available in 10 of the 46 rest areas in the network (21.74%). No restaurant or shops can be found. Finally, playing areas

for children and picnic areas, which can be necessary when travelling long distances, especially with kids, are offered in 67.39% and 84.78% of the rest areas, respectively (Fig. 7).

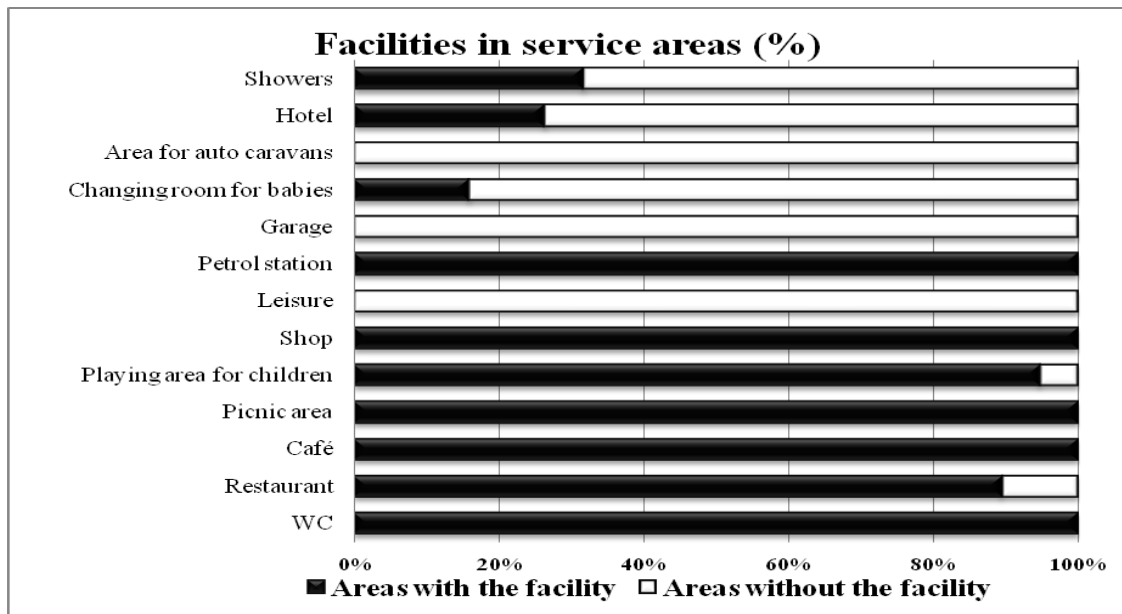


Fig. 6. Percentage of service areas that have each facility

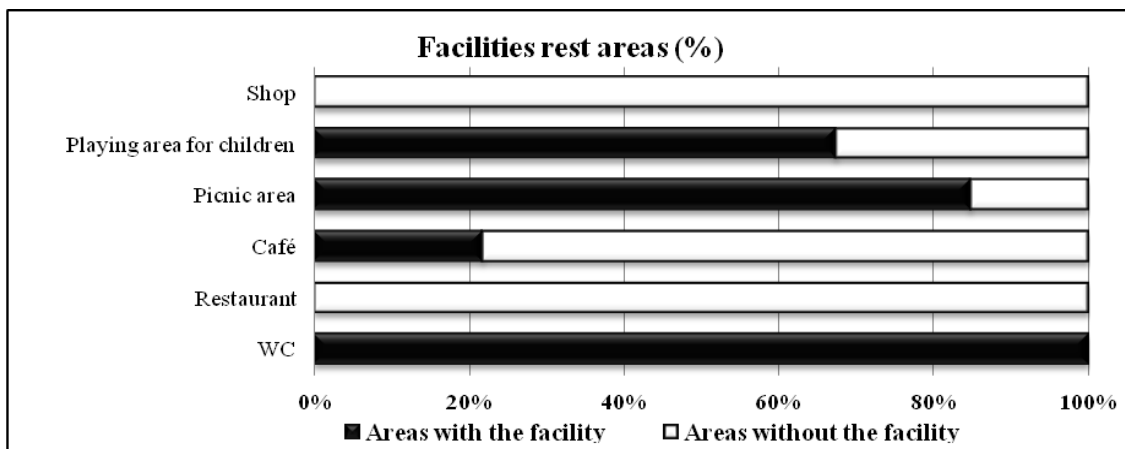


Fig. 7. Percentage of rest areas that have each facility

5. CONCLUSIONS

The article analyzes the services and facilities offered in the rest and service areas of the Polish toll motorway network. These areas are places near the road designed and constructed to provide services to road users with the aim to ensure a safe and comfortable journey. As fatigue is one of the main reasons for road crashes, rest and service areas are crucial elements in road networks. The distribution and the facilities included in these areas in paying freeways of Poland were studied as these infrastructures can be considered as a “*tunnel*” due to the fact that motorist do not leave them not to pay an extra cost for the journey, as it was certified by means of a survey on 124 motorists, highlighting that if it not totally necessary or it is planned, drivers do not leave the motorway for reaching a rest or service area. Laws in Poland only establish a minimum distance between areas of 15 km, but no indications are given for maximum distances.

The average distance between service areas in the three toll motorways of Poland is 40.49 km and 19.70 km for any type of area. The minimum distance between areas with facilities or services that imply competence is over 15 km, as indicated in the Polish law, with the exception of a stretch in the A-1 motorway, where two café are located within a distance below 10 km, in both directions.

The average maximum distances for rest and service areas are 40.68 km and 63.54 km, respectively. These values can be regarded as high. The maximum distances found in the entire network are 49 km for rest areas and 80.3 km for service areas, which are over the maximum distances established in other countries. This limit should be regulated in the Polish laws as it could improve road safety in these infrastructures.

All the service areas include a petrol station, toilets, café, and a shop, as imposed in Polish law. Other services are not so often available, like showers, hotels and changing rooms for babies. No garage or areas for auto caravan are offered.

Toilets can be found in all the rest areas, according to the requirements of the regulations. Picnic areas and playing areas for children are common in these areas, but café, which is optional, is not so frequently available.

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