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PASSENGER CARS TESTED AT THE MOTOR TRANSPORT INSTITUTE IN THE 1950s OF THE 20th CENTURY – THE PROTOTYPE OF THE FSO SYRENA

SAMOCHODY OSOBOWE BADANE W INSTYTUCIE TRANSPORTU SAMOCHODOWEGO W LATACH 50. XX W. - PROTOTYP FSO SYRENA

ПАССАЖИРСКИЕ АВТОМОБИЛИ, ПОЛУЧЕННЫЕ В ИНСТИТУТЕ ОСЕННЕГО ТРАНСПОРТА В 50-Е ГОДЫ XX В. - ПРОТОТИП FSO SYRENA

Abstract

The article presents and characterizes the results of road tests that the prototype of the FSO Syrena passenger car underwent at the Motor Transport Institute (ITS) in Warsaw in 1955. The final report from the tests carried out at MTI, kept in the archives, was subject to a detailed analysis and the conclusions have been presented in this article. The road tests carried out at MTI in 1955 served the FSO engineers in designing the series-production version of the Syrena car, whose production started in 1957. The FSO Syrena, over almost 30 years, was the first popular car for hundreds of thousands of Polish families, and today it has become a legendary vehicle, synonymous with the motoring of the PPR's day.

Keywords: *passenger cars, popular car, prototype, Passenger Automobile Factory, FSO Syrena, road tests*

Streszczenie

W artykule zaprezentowano i scharakteryzowano wyniki badań drogowych, które przeszedł w 1955 roku w Instytucie Transportu Samochodowego (ITS) w Warszawie, prototyp samochodu osobowego marki FSO Syrena. Przechowywane w archiwum sprawozdanie końcowe z przeprowadzonych w ITS badań poddano szczegółowej analizie, a wnioski zaprezentowano w artykule. Badania drogowe przeprowadzone w ITS 1955 r. posłużyły inżynierom z FSO przy projektowaniu seryjnej wersji samochodu Syrena, którą rozpoczęto produkować w 1957 r. FSO Syrena, na przestrzeni niemal 30 lat, była pierwszym samochodem popularnym dla setek tysięcy polskich rodzin, a dziś stała się pojazdem legendarnym, synonimem motoryzacji doby PRL.

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Słowa kluczowe: *samochody osobowe, samochód popularny, prototyp, Fabryka Samochodów Osobowych, FSO Syrena, badania drogowe*

Аннотация

В статье представлены и характеризуются результаты дорожных испытаний, прошедших в Институте автомобильного транс-порта (ITS) в Варшаве, прототипе пассажирского автомобиля FSO Syrena в 1955 году. Был подробно проанализирован окончательный отчет исследований, проведенных в ИТС, хранящихся в архивах, и выводы были представлены в статье. Дорожные испытания, проведенные в ITS 1955, служили инженерам FSO при разработке серийной версии автомобиля Syrena, который был запущен в 1958 году. FSO Syrena, почти 30 лет назад, был первым автомобилем, популярным для сотен тысяч польских семей, и сегодня он стал транспортным средством легендарный, синонимичный с автомобилем в день Польской Народной Республики.

Ключевые слова: *легковые автомобили, популярный автомобиль, прототип, Fabryka Samochodów Osobowych, FSO Syrena, дорожные испытания*

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The statement of the problem in general outlook and its connection with important scientific and practical tasks.

Work on the first Polish prototypes of cars after the Second World War began quite late, because it started in the early 1950s. Until that time, the Polish roads were dominated by post-military, often still war, American, Soviet and German cars. At the end of 1951, the production of Warszawa M-20 cars (or rather Gaz M20 Pobieda) began under a Soviet license. However, the Warszawa car was intended for public officers or taxi companies- it was a large and a "gas-guzzling" car. The development of individual motorization was not assumed, partly for ideological reasons (the car was synonymous with bourgeois luxury), and secondly for economic reasons (Polish industry was only just rebuilding after the Second World War hecatomb). Over time, however, when the first Warszawa M-20 cars were already going on Polish roads, the idea of a popular car for the masses with a small engine appeared. The desings of the prototype were started to be prepared. The first of these prototypes were constructed using the trial and error method, often adapting solutions from other already existing foreign vehicles (DKW, IFA-F8, Aero). The method of adaptation made the first Polish prototypes of passenger cars very imperfect and with many defects. The first two of these prototypes were called “Gad 500” and “Pionier” and were powered by engines designed by engineer Stefan Gajęcki (Berkan J. 2007; Zakrzewski B., Pawlak P. 2014; Zakrzewski B. 2010). While the Gad was a car designed as a convertible, the Pioneer was supposed to be a whole family of cars, including the commercial and ambulance versions. Ultimately, however, only prototypes of the vehicles not introduced to serial production were developed (Zakrzewski B., Pawlak P. 2014).

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In July 1953, a few months after the death of USSR leader Józef Stalin, using, among others, experience from road tests carried out with the Gad and Pionier, a team of designers composed of Kazimierz Studziński, Jerzy Werner, Stanisław Panczakiewicz, Karol Pionnier, Kazimierz Dębski and Fryderyk Blumke presented the official construction designs of the new popular car. In these designs, the new popular car was to be a four-passenger vehicle of the 2+2 scheme (and therefore a family car) with a two-stroke engine of about 22 hp. By the way, the designers were to achieve the lowest possible production costs, maximum economic efficiency in operation and the greatest possible unification of parts with the Warszawa M20 car. As in the case of the Gad and Pionier, the engineering team drew a lot of inspiration from the German IFA F8 and F9 cars or the DKW car (Górski M. 2009).

At the end of 1953 the first prototype units were made in two bodywork versions: the first one consisted of a wooden frame covered with fibreboards (design by S. Panczakiewicz, with, e.g., the P70 as a pattern), the second one was made of steel with a large number of elements from the Warszawa M20 (S. Łukasiewicz). The prototypes were named "Syrena" and premiered on the New Year's Eve in 1953 and 1954. Throughout 1954, road tests of the prototypes were carried out and several more prototypes were manufactured. In the end, the more prospective version was the steel sheet version of the car. The first public presentation of an already refined car took place in July 1955 at the 14th Poznań International Fair (Podbielski Z. 2013). The small-sized FSO Syrena was supposed to be cheap and efficient. However, serial production started only in 1957 and private persons could buy it only in 1958. (Szczerbicki T. 2016).

Before starting the car production, the prototype of the FSO Syrena passenger car underwent road tests at the Motor Transport Institute in Warsaw (Zakrzewski B. 2017). Such road tests, including those under road conditions, were extremely important. At that time, the Institute was the only institution capable of conducting full road tests (Zakrzewski B. 2012). Only the Institute had suitably qualified staff and high-quality instruments and equipment to carry out such tests. Their results were therefore of great importance for the then notables mainly from the Ministry of Road and Air Transport. They decided which vehicles can be driven on Polish roads, which vehicles and how could be produced. The opinions of the MTI experts were therefore overwhelmingly in line with subsequent decisions concerning entry into service or the production of vehicles tested in the MTI. A well-assessed car was roadworthy and in the case of foreign cars the green light for the import of these vehicles into Poland was lit. Bad test results and then unfavourable opinions of the MTI experts resulted in making decisions on further works on prototypes of Polish popular vehicles (Warszawa M-20, Syrena) or prototypes were approved (EMW340, P-70, Wolga M-21 Skoda 440) or the idea of importing the tested foreign constructions to Poland was abandoned (Standard Delivery Van) (Zakrzewski B. 2012). The article presents and discusses for the first time the results of tests of the FSO Syrena passenger car prototype, found in the MTI archive. This article is related to the author's other research that has been conducted for several years now, concerning the development of the Polish post-war motor industry (Krysiuk C., Zakrzewski B., et al. 2012).

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The analysis of the latest research when the problem solution was initiated.

The idea of the popular FSO Syrena car was very often discussed in the Polish automotive press at the time when the MTI tests were underway, thus in 1955, e.g. in the only then opinion-forming automotive weekly titled "Motor". (Dehnel J.R. 1958). It describes in detail, amongst others, the experimental rally of the Syrena prototypes. Most of the book studies that have been published so far, concerning the history of the Syrena car, are of a popular scientific nature. In recent years, books on this subject have been published by Tomasz Szczerbicki (Szczerbicki T., 2016). Karol Mórawski's book (Mórawski J.K. 2005) is another work on the Syrena car. The Polish automotive industry in the era of the People's Republic of Poland, including the Syrena in the form of short characteristics, is discussed in books by Włodzimierz Bukowski (Bukowski W. 2009), Adam Zakrzewski (Zakrzewski A. 2009), and Stanisław Szelichowski (Szelichowski S. 2012). Many interesting books on the history of Polish post-war automotive industry, including the Syrena, were also written by Zdzisław Podbielski (Podbielski Z. 2013) and Andrzej Zieliński (Zieliński A. 1985; Zieliński A. 2008). All the authors mentioned above are not graduated from history studies and most often are journalists or engineers who took part in the works of scientific institutions related to the automotive industry (PIMOT, OBRSM in Bielsko-Biała). Their publications do not have an extensive critical review apart from the selective bibliography and are based mainly on their own memoirs, chaotically acquired photographs and illustrations, partly only on reviewed archives. They are therefore incomplete and not strictly scientific. On the other hand, the papers of former researchers of the motorization history, such as Witold Rychter (Rychter W. 1987), Aleksander Marian Rostocki (Rostock A. M. 1981), Kazimierz Groniowski (Groniowski K. 1963) are largely outdated today. The author of this article also wrote about cars in the years 1945-1990, including the Syrena, but quite generally (Zakrzewski B. 2012; Wiechczyński K., Zakrzewski B. 2017). It will soon be 30 years since the fall of communism, i.e. since 1989, and this is a good time for the first summaries of the Polish automotive industry role in the national economy, including the history of the FSO Syrena car. This article fills a gap in the scope of the beginnings of the Polish post-war motorization history and the creation of the FSO Syrena car.

Aims of the paper. **Methods.**

The aim of the article is to present how the road tests of the FSO Syrena car prototype were carried out at the MTI and what the results were. Furthermore, whether and how this research contributed to the repair of the prototype and to the commencement of serial production of the FSO Syrena passenger car. For this purpose, an analysis of a prototype of the FSO Syrena passenger car, performed in the MTI, was conducted for the first time. Based on the analysis, appropriate conclusions were reached. **The basis** for the analyses was a search carried out by the author in the archives of the Motor Transport Institute in Warsaw, a literature research in the MTI Library, as well as information, including statistics, collected from available sources, literature and reports. The main **research method** is observation, analysis and reasoning.

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Exposition of main research materials with complete substantiation of obtained scientific results. Discussion.

In the archives of the Motor Transport Institute in Warsaw two papers concerning the research of the Syrena prototype have been preserved. In mid-1955, a prototype test of the Syrena car was carried out at the Motor Transport Institute in Warsaw and it ended with an experimental rally. The research started on 20 July 1955 and ended on 31 August 1955. It was conducted by Aleksander Rummel, PhD, and Andrzej Cichowski, PhD, at the Traction Testing Laboratory of the MTI Vehicle Research Institute (Rummel A., Cichowski A., 1955). The test was controlled by the Head of the Vehicle Research Department, Aleksander Rummel M.Eng and accepted by Lesław Bochniewicz M.Eng, the then (first) MTI Director. The work was carried out for the Technical Department of the Ministry of Road and Airports. According to the distribution list, the final report from the completed works was sent to, inter alia, the Department of Technology of the Ministry of Road and Air Transport, FSO, BKPMot., WSM No. in Bielsko-Biała, as well as the Cracow University of Technology.

The subject of the research was a prototype of the small passenger Syrena car with an S15 engine, with an engine number: 00011, a chassis number: 00006, delivered for research to the MTI by the FSO on 20 July 1955. The aim of the research was a preliminary assessment of the design solutions of individual units, the quality of workmanship, and the vehicle's movement and operational properties. The scope of the research included: exploitation tests at the MTI over a distance of 2 500 km, participation in an experimental rally organised by the FSO from 14 to 31 August 1955, and a preliminary analysis of the structure made on the basis of the conducted observations and measurements.

The car was accepted for tests with 7 000 km mileage. According to the test agenda approved by the Commission for Car Type Assessment, the tests included the stage of development of the technical characteristics made by the FSO. Initial research was carried out at the Institute and an experimental rally was organized (Rummel A., Cichowski A., 1955). The experimental rally organised by the FSO took place between 14th and 31st August 1955. In addition to the 5 FSO Syrena cars, the rally was also attended by an imported Renault 4CVs, Panhard Dyna, DKW SM and Goliath GP 700Fs. The rally took place on the Warsaw-Rzeszów-Bielsko-Kłodzko-Koszalin-Warsaw route with a total length of 5 500 km. The route of the rally included various types of roads, including those leading through mountainous areas.

During the rally a number of damages and deficiencies of the FSO Syrena prototype were found. After the end of the rally the total mileage of the Syrena prototype was 15463 km. At the Institute technicians dismantled the engine and found damages to the pistons, cracking of piston rings, grooves in the piston rod of the second cylinder made by the piston pin (due to the loss of the safety ring), cracking of the crankcase seals, significant wear of the main bearings of the crankshaft and excessive wear of cylinder bearing surface. In addition, cracks in the suspension springs of the clutch centre plate were found.

The engine power of 23.4 hp was too low in relation to the vehicle weight of 860 kg. The characteristics of the engine showed a breakdown of power in the area of the most frequently used engine speeds, which had a negative impact on the dynamic properties of the car. Average fuel consumption before the rally was 9.3 dm^3 per 100 km but

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during the rally it increased by 1 dm^3 to 10.3 dm^3 per 100 km. This consumption was too high - it should be about 7.5-8 dm^3 per 100 km. The poor quality of the piston and piston ring designs and the insufficient durability of the crankshaft bearings were confirmed. During the rally there was an excessive wear of the cylinder bearing surface - the maximum/minimum wear of the cylinders in the area of the highest piston speeds was caused by mechanical impurities on the bearing surface. After 9 000 km, a radiator leak also occurred due to inadequate attachment of the radiator to the body and an overly rigid rubber hose which, during engine movements, created excessive stress at the point where the connection pipe was soldered to the water jointer. It was also found that the suspension springs of the clutch centre plate cracked due to their low quality and the clutch cable pulled out significantly.

During the rally, an inappropriate selection of gears in the gearbox was found. The MTI experts considered it advisable to concentrate the lower gears, especially the 3rd and 4th gears, in order to increase the speed of the 3rd gear by a positive amount. The suspension of the front wheels was too rigid. To sum up, the Syrena car was too heavy, but it could be "slimmed down" by at least 40 kg. However, for the dynamic properties to be appropriate, the motor should have at least 30 hp at 4000 rpm. This two-stroke Syrena engine should have a displacement volume of approx. 900 cm^3 and a three-cylinder engine has been suggested. If the S15 engine is left in place, it should be refined to ensure maximum durability and low engine wear. In addition to the need to carry out further work to reduce the vehicle weight and to make changes to the engine or suspension, the following activities were suggested:

- use the external opening of the tailgate,
- use a less rigid line to connect the radiator to the engine and install the "flexible" line to the radiator,
- install the double fastener of the engine bonnet,
- slide the brake and clutch pedals away from each other,
- bend the backrest tube more so that the seated person does not lean against it,
- install the rests under the elbows in the rear seat,
- analyse the arrangement of the grease nipples of steering arms in the direction of their possible lubrication without an articulated coupling.

In mid-1955, the Motor Transport Institute in Warsaw carried out further prototype tests of the Syrena car. The research work, which began on 20 July 1955 and ended on 7 August 1956, lasted more than a year. The research was conducted by Aleksander Rummel, MA, and Andrzej Cichowski, MA, in the Traction Testing Laboratory of the MTI Vehicle Research Institute (Rummel A., Cichowski A., 1956). The work was accepted by Lesław Bochniewicz, MA, then (the first) MTI Director. The work was carried out for the FSO in Warsaw. According to the chapter, the final report in the completed works, as in the case of the first work, was sent to, among others, the Department of Technology of the Ministry of Road and Air Transport, FSO, BKPMot., WSM No. in Bielsko-Biała, as well as the Cracow University of Technology. Jerzy Kowal, Adam Kleczkowski MSc Eng. and Jan Zrobek, MSc Eng, from the Cracow University of Technology (design analysis), Jerzy Brożyna, MSc Eng, and Bogdan Bojski, MSc Eng, from the MTI (engine research) and Józef Karney, a technician from the MTI (motion measurement) were also participated in the tests.

The aim of the research was the final assessment of the constructional solutions

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and the operational and exploitation properties of the Syrena car prototype. The subject of the tests was a prototype of a small passenger car "Syrena" with a S15 engine, of an engine number: 00004, a chassis number: 00006, delivered for research to the MTI by the FSO on 20 July 1955 (after the completion of the experimental rally another engine was installed into the prototype). The research was carried out in three stages: The first stage included dynamometric tests of the engine with the development of universal characteristics, the second stage included movement and static tests, the third stage - construction analysis for which disassembly and additional measurements of individual components were carried out. Maintenance and installation issues were also examined as part of this work. Long-term tests were carried out as part of the movement tests, including observation of the behaviour of individual components and assemblies. Dynamic tests, braking and fuel consumption curves were carried out on the Łomianka-Kazuń road. The suspension tests were carried out on selected sections of the Żoliborz-Wawrzyszew-Bielany road, while other consumption tests were carried out on the city route and on the Warsaw-Wyszków-Pułtusk-Warsaw inter-urban road. The following apparatus and devices were used during the tests:

1. Heonan-Froude DP water brake x 2,
2. Muhlner electric flow meter for fuel consumption measurements,
3. 5 Hassler wheel,
4. 5 Peiseler wheel,
5. Self-recording Askania Accelerometer.
6. Muhlner steering wheel force measurement device,
7. Muhlner pedal force measurement device,
8. Radiometer sound intensity measurement device,

The scope of the research also included: technical description, engine tests on a dynamo-metric stand, static car tests, economic car tests, motor tests, development of a universal traction diagram, structural analysis and conclusions.

The prototype of the FSO Syrena car tested at the MTI was of: length: 4050 mm, width: 1540 mm, height: 1510 mm, wheelbase: 2300 mm, front and rear track width: 1200 mm, mass: 962 kg, mass with full load: 1302 kg. The prototype of the Syrena had a WSM 1 Bielsko-Biała S15 engine with the number 0004, a two-stroke engine with two cylinders arranged in a row. The diameter of the cylinder was 76 mm and the piston stroke- 82 mm. The engine's displacement was 743.5 cm^3, the actual compression ratio was 5.2 and the maximum power was 27.8 hp. The elastic coefficient was 1.21 and the coefficient of rotation was 0.526. The prototype had a Solex 30 UAHD and Jikov POH carburetor. The engine was cooled by a 6 dm^3 self-circulating liquid and was lubricated with a 25:1 fuel-oil mixture, and it also had battery ignition, two coils and two breakers with automatic acceleration of the ignition torque. Spark plugs- 14 mm, Bosh W 175 T1type. The weight of the motor and its accessories was 67 kg.

The prototype of the Syrena had a longitudinal welded frame with a rectangular closed section. The clutch was dry, single disc, with vibration damping. The gearbox was locked with motor, 4-speed without synchronisation, 3rd and 4th gear quiet with freewheel. The gear lever system was under the steering wheel and switched by a coupling link and a cable. The diameter of the steering wheel was 440 mm.

The wheel alignment for the unladen vehicle was 3.0 mm, the smallest turning radius was: right-5.5 m, left- 4.95 m; the smallest turning radius when turning back: right: 5.75 m, to the left: 5.40 m

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The prototype Syrena had a hydraulic four-wheel brake system. The diameter of brake drums was 280 mm, total lining surface: 600 cm^2. Brake piston dimensions: ¾ inch. The parking brake: mechanical (cable), for rear wheels. The Syrena prototype had a suspension: forward-independent, semi-elyptical traverse leaf spring at the top, triangular swingarm mounted in the shock absorber at the bottom, rear - semi-elliptical traverse spring highly mounted, rigid axis, shock absorbers: hydraulic, two-sided, two on the front, one rear mounted in the middle of the axis. Steel wheels, pressed from sheet metal, dimensions: 3.25 D x 16; tyres: size 5.00 x 16; air pressure: front 1.8 atm, rear 1.7 atm. The electrical installation and equipment consisted of:

- generator: adjustable voltage and current, 130 W, 12 V;
- starter: can be electromagnetically switched by pressing a button on the dashboard;
- battery: lead, 12 V and 60 Ah;
- control instruments: speedometer with odometer, ammeter, cooling water thermometer, clock, indicator control lights and lamps control lights;
- ignition system: two ignition coils (M42-04 type) and two breakers, separate for each cylinder. Central automatic ignition acceleration mechanism;
- electric wiper with two blades with two speeds of movement.

The body of the Syrena prototype is a two-door saloon. The body had a mixed structure: its lower part was covered with metal sheet, and its upper part with a wooden frame was covered with artificial leather-dermatoid. Metallic framed seats were made of microporous rubber. Front seats had the ability to adjust the angle of the backrest and to move away from the pedals. The backrests of the front seats could be folded out. The interior and windscreen could have been heated by the warm air blast from the radiator via the motor fan. The luggage compartment was located at the rear of the bodywork and was accessible when the backrest of the rear seat tilted. The spare wheel was placed under the boot and accessible when the tailgate was opened, which was released from the inside of the body.

Capacities were: fuel tank - 35 dm^3, cooling system - 6 dm^3, oil in drive systems - 1.5 dm^3, capacity of front shock absorbers - 0.47 dm3, rear shock absorber - 0.145 dm3, brake system - 0.4 dm^3.

After getting acquainted with the car, the speedometer and distance counter were scaled up and indicative measurements of accelerations were taken. The prototype covered 2 584 km, including 79% on good roads, 12% on bad roads and 9% on city roads. The fuel consumption was 241 dm^3 (petrol-oil mixture) which gave an average consumption of 9.3 dm^3/100 km. The speedometer was calibrated in accordance with NM 06001 which is shown in the table below.

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Table 1. Results of the FSO Syrena prototype speedometer scaling at the MTI

Speed acc. to the speedometer	Actual speed	Error
20 km/h	21 km/h	- 5 %
30 km/h	29 km/h	+ 3 %
40 km/h	40 km/h	0
50 km/h	51km/h	- 2 %
60 km/h	62 km/h	- 3 %
70 km/h	74km/h	- 6 %
80 km/h	86 km/h	- 7 %

Source: compiled by the author based on the report (Rummel A., Cichowski A., 1956).

In order to estimate the dynamic properties, acceleration measurements were carried out in 3rd and 4th gears and during acceleration by gears. The measurements were made by measuring with a stop watch the time after which the assumed speed was reached. The atmospheric conditions during the measurements were as follows: side wind speed 0.5-0.7 m/s, temperature +28˚C, dry roadway. The measurements were made on the concrete roadway of Łomianka-Kazuń with the load of two passengers.

A test for short operational characteristics of the prototype was also carried out. The results of measurements were performed with two passengers in the car. In the test, the error of the speedometer display was: at 50 km/h - 2 %, at 90 km/h - 8 %. The error of the distance meter readings was 4 %. The braking measurements at 45 km/h were:

Average deceleration:

47% g (4.61 m/s^2) with 40 kg pedal pressure

67% g (6.57 m/s^2) with 70 kg pedal pressure,

74% g (7.26 m/s^2) with 100 kg pedal pressure.

The MTI experts also measured the maximum speed that the prototype could develop. The maximum speed (1 km from the flying start) when the average of the four measurements was 97.4 km/h. The best result of the maximum speed was 102.9 km/h. The minimum and maximum speeds in each gear were as follows: 1st gear- from 5.5 to 28.0 km/h, 2nd gear- from 9.0 to 45.0 km/h, 3rd gear- from 16.0 to 64.0 km/h, 4th gear- from 25.0 to 97.4 km/h. Gear acceleration times were: from 0 to 48 km/h - 13.5 s, from 0 to 65 km/h - 22.0 s, from 0 to 80 km/h- 41.5 s.

The fuel consumption of the prototype FSO Syrena tested at the MTI under urban driving conditions with two passengers was as follows: at an average speed of 30 km/h: 9.6 – 10.15 dm^3/100 km; with 4 passengers, at speeds: 25 - 30 km/h was from 10.4 to 12.4 dm^3/100 km.

The prototype of the FSO Syrena car, tested by the Motor Transport Institute, is presented in the pictures below published for the first time (Fig. 1, 2, 3).

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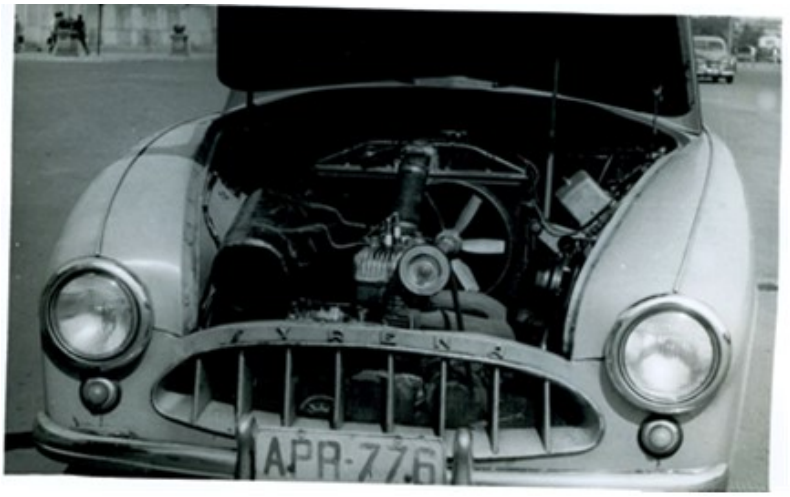
Fig. 1 The prototype of the FSO Syrena car tested at the MTI at Bank Square in Warsaw.

Source: Archive of the Motor Transport Institute

Fig. 2 The prototype of the FSO Syrena car tested at the MTI –view at S15 engine.



Source: Archive of the Motor Transport Institute

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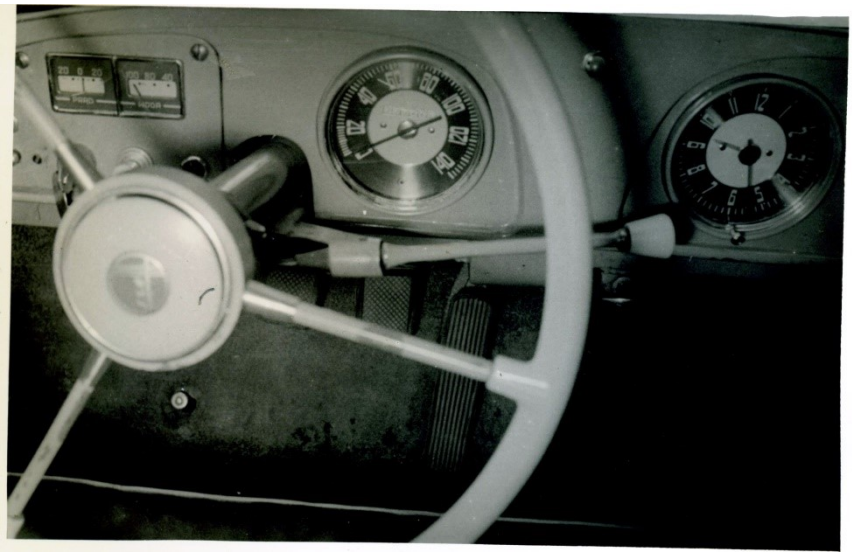
Fig. 3 The prototype of the FSO Syrena car tested at the MTI – view at the whole dashboard.



Source: Archive of the Motor Transport Institute

Fig. 4 The prototype of the FSO Syrena car tested at the MTI at Bank Square in Warsaw– the vehicle rear.

Summarizing the research conducted at the MTI, it should be noted that the concept of production of the FSO Syrena car based on the elements of the FSO Warszawa car (M20 Pobieda) in the existing conditions and reality of the mid-1950s, for those

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times and considering the conditions of the Polish automotive industry development, was right. The efforts of the designers who developed the car should also be assessed positively. As a result of the research, excessive weight of the prototype was found, which resulted from its constructional connection with a much larger FSO Warszawa car and small production scale, so that a significant weight reduction was not possible under these conditions and was accepted as a necessary evil.

The choice of a two-stroke engine, with the technological possibilities of the time and until the launch of the production of appropriate four-stroke engines, was right, although it could be a three-cylinder engine with a higher capacity and power of e.g. 34 hp, which would bring the FSO Syrena car closer to other modern small-sized cars. In the reality of Poland in 1955, the prototype of the Syrena car had an undoubted utility value and was further developed in terms of its design and technology - many of the car modifications were created. Works on its construction were carried out as far as possible until the mass production of the car, popular for average Poles, was fully launched. In 1955, experts from the MTI suggested that, apart from the launch of a test series, the possibility of undertaking construction works on the following should be considered as soon as possible:

1. a three-cylinder two-stroke or two-cylinder four-stroke air-cooled engine.
2. improvement of front wheel suspension kinematics and suspension,
3. improvement of the braking system,
4. body improvement.

The MTI experts for the test car series "Syrena" would suggest:

- using a Jikov carburettor and continuing to improve engine performance,
- reducing the third gear ratio so that the attainment speed in this gear is approx. 70 km/h at 4200 rpm. Changing the main gearbox at the moment is not considered advisable as it will cause further lowering of the already low dynamic ratios of the car,
- changing the clutch in terms of design and technology, as the current clutches prevent normal vehicle operation,
- changing the gear-shifting mechanism design by using the longitudinal gear stick system,
- reducing the suspension in the first row by reducing the damping effect of the dampers,
- using 5.50 x 15 tyres (move to a 13-inch rim in the future if necessary),
- using the external opening of the boot,
- installing the double fastener of the engine bonnet,
- installing the rests under the elbows in the rear seat,
- changing the arrangement for the grease nipples of steering arms for easy lubrication.
- strengthening the handlebar stem for easy lubrication,
- strengthening the handlebar stem,
- improving the attachment of the radiator,
- improving the heating system to increase its performance.

Many of these amendments were applied already two years later, when the serial production of this vehicle began.

Conclusions.

Over half a million Syrena cars produced in various versions (Syrena 100, 101, 102, 102 S, 103, 103 S, 104, 105, 105L, R-20, 105 Bosto) have made the history of the

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Polish automotive industry. The structural changes in the subsequent types were introduced on an ongoing basis and were often mixed in the previous model and its successor model. This does not change the fact that the construction of the familiar Syrena was obsolete already in the 1950s. In addition, the quality of implementation was poor and the FSO's specific actions for its improvement were minimal (Dembiński J. 2004). In 1964, the production of the Syrena 104 began with a new three-cylinder S-31 engine, which improved its performance, but this performance began to exceed the capabilities of the chassis, which highlighted the archaism of the structure, e.g. suspension. In 1967, for the first time there were plans at ministerial level to discontinue production of the Syrena car. The reasons for this were: outdated design, poor quality, uselessness in state institutions and enterprises, finally a license agreement signed with Italy for the production of the Fiat 125 car (Podbielski Z. 2009), and then the Fiat 126. However, the Fiat 125 was a much more expensive car than the Syrena car and could not constitute a valuable competition for the domestic popular car. In 1972, production of the Syrena was transferred to Bielsko-Biała. From the mid-1970s until the end of its production, the Syrena car became a typical village and small-town vehicle. In the country it was a relatively cheap but structurally simple vehicle. All this meant that in view of the weak saturation of the Polish market with cars, for which we had to wait for years, the production of the Syrena lasted until 1983. The last Syrena was assembled on 30 June 1983. (Podbielski Z. 2013).

The prototype of the FSO Syrena passenger car presented in the article was examined in the Motor Transport Institute in 1955 by outstanding experts such as: engineer Aleksander Rummel (Piłatowicz J., Zakrzewski B. 2011) (creator of the prewar Lux Sport car) (Zakrzewski B. 2012) and engineer Andrzej Cichowski. The results of these studies stored in the MTI archives in the form of a final report provide unique photographs and tables, published for the first time in this article. The results of research on the prototype of the Syrena FSO passenger car carried out in the MTI showed many defects of this car and had a significant impact on the improvements made to it before starting serial production. In 2011, there was a decision to reactivate the Syrena car. There was money from the EU funding from the Innovative Economy Program. The value of the project amounted to PLN 7.44 million, of which the EU support amounted to PLN 4.5 million. The result is a driving prototype of the Syrena powered by an engine from General Motors. The new prototype of the Syrena (which was also tested in the MTI) participated even in the road collision in 2016. Unfortunately, the new Syrena, the production of which was to be started in 2016 (the FSO's cooperation with AMZ company from Kutno), has not reached the consumer. Perhaps it will be produced in an electric car version.

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