



Received: 15.05.2016

Accepted: 30.09.2016

Invited Editor: Mahmut Hekim

Area Editor: Cem Emeksiz

## Runway Lighting and Lighting Control Systems: Example of the Erzincan Airport

Mustafa ŞAHİN<sup>a,1</sup> ([mustafasahin@erzincan.edu.tr](mailto:mustafasahin@erzincan.edu.tr))  
Yüksel OĞUZ<sup>b</sup> ([yukseloguz@aku.edu.tr](mailto:yukseloguz@aku.edu.tr))  
Tarık TAŞCI<sup>c</sup> ([tariktasci@yahoo.com](mailto:tariktasci@yahoo.com))

<sup>a</sup>Erzincan University, Engineering Faculty Electrical & Electronics Engineering Department, 24000 Erzincan

<sup>b</sup>Afyon Kocatepe University, Technology Faculty, Electrical and Electronics Engineering Department, 03200, Afyonkarahisar

<sup>c</sup>State Airports Management General Directorate of Erzincan Airport, 24000, Erzincan

**Abstract** – The purpose of this study; In order to perform a safe landing and takeoff of the aircraft, It is to examine the runway lighting system, light guidance elements and the control unit of these equipments. Based on this information in the study, of Erzincan airport runway lighting system has been examined. Runway lighting system are investigated as threshold lights, runway threshold identification lights, runway end lights, runway center line lights, runway edge lights, touchdown zone lights, taxiway edge lights, taxiway center line lights. Also, stop bars, approaching fixtures, runway fixtures, runway edge fixtures, beacon light system, PAPI and so on. Lighting components and related to them, are given extensive information about the control systems.

**Keywords** –  
Runway lighting  
system, Erzincan  
Airport, light  
guidance elements

### 1. Introduction

In parallel to the development of technology, as in all areas of the aviation industry is also developing rapidly. With this development, the existing airports are added every day a new one and each new airport is built, it offers more technologically advanced services available airports. Ensuring the landing and takeoff safety comes at the beginning of these services. During the takeoff and landing of aircraft must be guided safely. International Civil Aviation Organisation (ICAO) established a set of standards such as the sizing of runway lights, flashing range. Regulations have been prepared for these standards. Many

---

<sup>1</sup>Corresponding Author

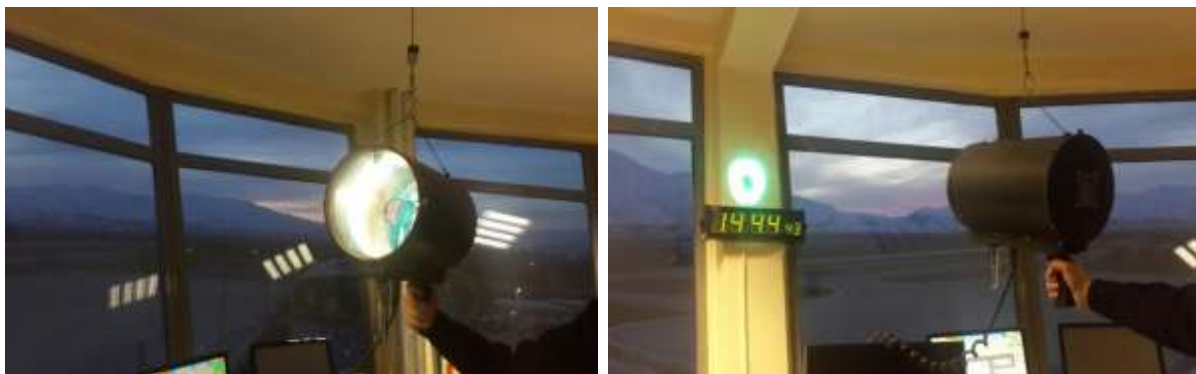
subjects in the Regulation is described as supplemented by explanatory figures and pictures such as functional requirements of visual ground assist, markings and markers, signal area and billboards, light features and taxiways will be used for low visibility conditions, light intensity adjustment, orientation lighting system into the runway, tours to guide lights, visual approach slope indicator system, runway and taxiway lighting, surface movement guidance and control systems, signboards, visual parking and parkland visual guidance systems, lighting of the apron with the projector, marking and lighting of obstacles, the breaking ability of the visual aids, implementation of approach and runway lighting system, maintenance of lighting performance and the measurement of light intensity of fixed light and flashing lights etc.

Regulations are prerequisites for the correct design and installation of visual aids and the safety and regularity of civil aviation. With lights arranged in accordance with these regulations, when pilots approach the runway, they can understand some information as the layout of runway from the color of runway lights and the flashing frequency of light.

## 2. Major Lighting Elements Used in Aviation

### 2.1 Aldis (Signal Lamp)

It is a kind of signal lights that allows communication in the control tower to provide communication between the tower operators and aircraft pilots in the event of breakdowns in the system. In Figure 1, it viewed from different angles and allows communication with Morse Code, this signal lamp is called Aldis. Aldis can be signaled in green red and white colors [1].



**Figure 1.** The Aldis (signal light) view from different angles

### 2.2 Aerodrome Beacon

The mark of aviation is used for the recognition of an airport location in the air.(Figure 2). It exists at all airports that ready night traffic. It returns the light system that emits green and white light and flashing 12-30 times per minute inland airport . Lights of beacon could be seen from every direction, so it is often built on the highest point as the tower [2].



Figure 2. Aerodrome Beacon [3-4]

### 2.3 PAPI (Precision Approach Path Indicator)

Instrument landing system(ILS) placed at the head runway is a precision approach landing system that helps the aircraft via transmitter (Figure 3). Instrument landing system (ILS) is a navigation system that helps to get closer to the beginning of runway as precision approach. It ensure that the aircraft approach the runway in low level and make a safety landing by using electronic devices. ILS gives the informaiton about direction and glope line to pilot [5].



Figure 3. Instrument Landing System (ILS) [6]

Shown in Figure 4, PAPI system guides the pilot by providing a correct approach corridor at runway especially without ILS. light is seen in different colors at different heights in these systems.



**Figure 4.** PAPI (Precision Approach Path Indicator) [7]

## 2.4 Runway threshold lights

It is composed of at least 6 green light and directed to the landing direction to determine the runway threshold [1].

## 2.5 Runway threshold identification lights (RTIL)

It is very high intensity white light system to determine the runway threshold in low visibility conditions. It is located both sides of threshold lights and flash 60-120 times per minute [1].

## 2.6 Threshold Lights

Threshold Light is the green light series used in order to determine the location of the runway threshold (Figure 5). Threshold lights are mounted at the beginning of the runway or less than 3 meters from the beginning of the runway. They are manufactured in embedded type or surface type. It has to be at least 6 threshold lights at runway without ILS [8].



**Figure 5.** Threshold Light [9]

## 2.7 Runway End Identification Lights(REIL)

It is very high intensity white light system to determine the end of Runway in low visibility conditions. It located both side of threshold Runway end lights and flash 60-120 times the per minutes [1].

## 2.8 runway touchdown zone lights

In low visibility conditions, to determine the touchdown zone, located the 30/60 meter intervals on both sides of runway center line, 3 / 4,5 meters long is the white light system in the form of helmets[1].

## 2.9 Taxiway edge lights

It is blue color light to determine taxiway edge. They are placed at a maximum range of 60 meters [1].

## 2.10 Taxiway center line lights

In low visibility conditions, to determine the taxiway center line lights are placed at a maximum range of 30 meters. Located between the stop bars and runway axis, the point they leave runway lights are colored yellow and green others is green [10].

## 2.11 Stop bar Lights

Taxiway center line is positioned vertically unidirectional red light system that established to wait the plane, 3 meters exceeding the range. The part of entrance runway of taxiway, at taxiway junctions and waiting areas(Figure 6). They are produced with the embedded type. These lights are constantly "turn on" state.

They are turn off by Air Traffic Controller In case of traffic permitting. After the plane came on, automatically it turns on again [2].



Figure 6. Stop bar Lights [11]

### 3. Custom Lighting Fixtures and Features

It is ready to use the name given to luminaries lighting devices. It contains bulb, light filters that appear in color, and collecting light at a certain point of the lens and other related equipment. Fixtures illuminate an area the size determined. For example; apron lighting, lighting the football field, such as car headlights. Also fixtures mark the location of them. For example; stop lamps on vehicles, such as mânia lights. Runway lighting fixtures are used to determine their location is not a specific field lighting purposes.

Fixtures are divided into three types of physical properties; embedded type fixtures, semi-embedded type fixtures, surface fixtures [2].

#### 3.1 Runway Edge Lights

Runway edge lights located along the full length of the runway and will be equidistant from the center line in two parallel rows. Runway edge lights are lights placed up to 3 m from the outside edge of runway or along the edge of the runway (Figure 7) [8].



Figure 7. Runway edge light [12-13]

#### 3.2 Runway Centre-Line Lights

Runway Centre-line light (Figure 8), must be provided on Category I, especially runway used by aircraft with high landing speeds or in case of runway width is greater than 50 m between the runway edge lights, otherwise Runway center line lights on a precision approach runway category II and III will be provided.



**Figure 8.**Runway Centre-line light [14]

Runway Centre-line light is the red and white light system that placed at intervals not exceeding 15 meters until the end of runway from the runway threshold, In order to mark the runway axis [8].

### **3.3 Tower Control Panel**

Tower operators can run each system separately by controlling the lighting elements through the control desk that located in the tower.

## **4. Erzincan Airport Runway Lighting, Lighting and Control System Investigation**

Runway lighting systems of private standards is determined by International Civil Aviation Organization (ICAO).Control and applications in Turkey are carried out by Civil Aviation General Directorate and State Airports Management General Directorate (DHMI).In this study with both the PLC and the SCADA software it is intended to be shorter in duration and automatic control of runway lights. These standards have been also considered. In the subject of runway lighting systems to make them more understandable Precision Approach Path Indicator (PAPI) and runway edge lights are discussed as examples.

### **4.1 Precision Approach Path Indicator(PAPI)**

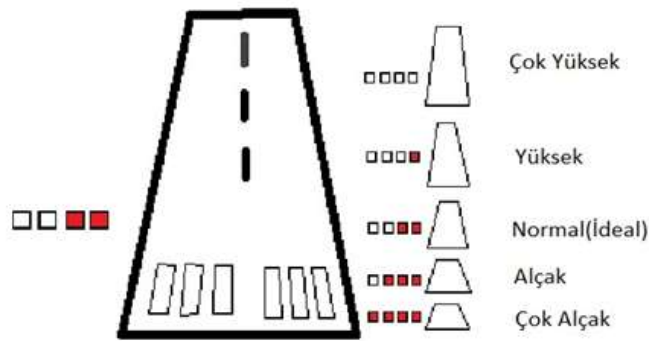
PAPI is the most powerful visual approach lighting systems. PAPI light beam is the first visual cue that can be seen by the pilot in daytime 6-15 km from the outdoors and in the open air at night from 15-30 km. In case of a direct approach does not have the ILS runway, PAPI system provide an accurate approach corridor and is used for guiding the pilot on the runway threshold. Light appears in different colors at different heights as shown in Figures 9.



**Figure 9.** PAPI Light appears in different colors at different heights

The following Figure 10 shows PAPI from the perspective of the pilot.

PAPI: Pilot'un Bakış Açısından



**Figure 10.** PAPI system from the perspective of the pilot

Therefore, PAPI works as ILS, if the ILS has not installed. Papi system is closely related to navigation safety. When used according to the instructions, the system is expected to provide the following:

- on the runway threshold of a safe minimum wheelbase,
- a margin of safety away from all obstacles in the final approach,
- whatever the physical characteristics of the runway, it will provide approach line that leads to aircraft to touchdown zone [2].

PAPI system comprises a side bar that arranged with equal interval of 4 sharp transition multi-lamp (or paired single lamp). It is located on the left side of the runway system, unless physically impossible to perform [15].



## 4.2 Runway Edge Lights

Runway edge lights located along the runway at equal distance from the center line and in two parallel rows. Runway edge lights placed at a distance up to 3 m long outside edges of areas or along the edges of the runway. Lights, are inserted properly rows. It is 60 m maximum intervals for runway with ILS, up to 100 m intervals for the runway without ILS. runway lights on opposite sides of the axis is still on-line at right angles to that axis lines. Runway lights at the intersection point may be placed at irregular intervals, if it provided that the appropriate guidance to the pilot. In Figure 11 Airport of Erzincan are given the appearance of runway edge lights.



(a)

(b)

**Figure 11.** Runway heading(a) and middle of runway (b), view of the runway edge lights

Runway edge lights are fixed in variable white light, except as specified in the following article:

- In case of a shifted runway threshold of, runway threshold of lights shifted from the beginning of the runway, will be the direction of approach and red.
- The first 600 meters of the runway from the end of the initial running or one-third of the runway length whichever is less, it may be yellow.
- Runway edge lights will be seen in every aspect necessary to provide guidance to a pilot that landings or departures in any direction.
- Runway edge lights from all angles, the runway visibility is intended for use for take-off or landing and a density suitable for ambient light conditions, it will be seen at angles up to 15 degrees above horizontal. Density in any case be at least 50 cd, but not a irrelevant illumination light intensity at the airport, the pilot's eyes to prevent glare can be reduced at least 25 cd [8-10].

## 4.3 Electrical connection of the runway fixtures

Fixtures on runway are fed as a hopping from two different regulators for security purposes. Thus, if Oneof the circuit has any problem, the other system is active. Figure 12 shows the runway edge lights circuit supply of the regulator circuit and Figure 13 shows the PAPI supply circuit of the regulator circuit.

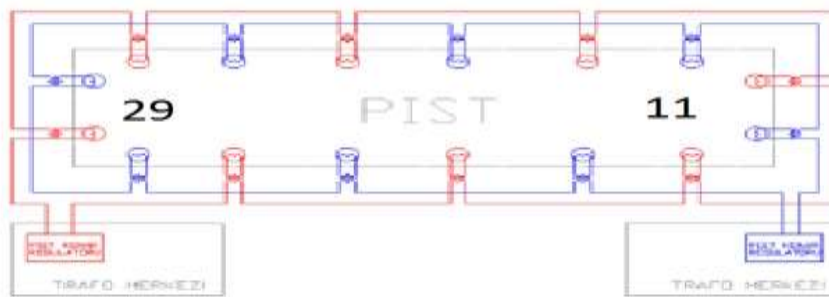


Figure12. Runway edge lights circuit regulator supply [16]

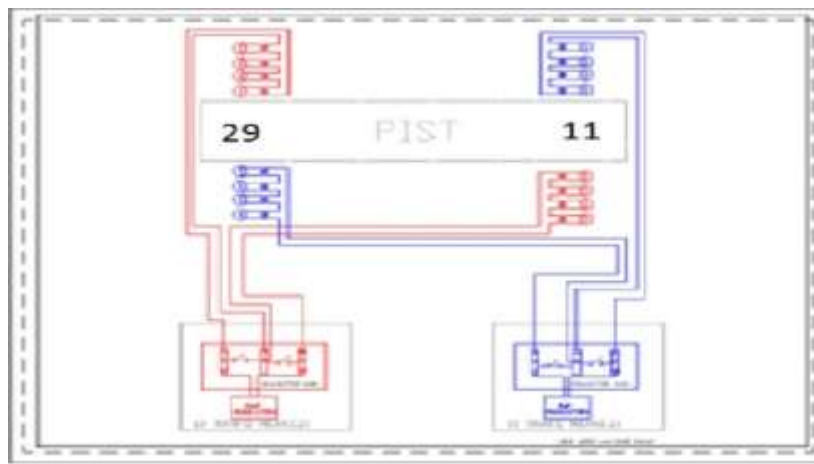


Figure 13. PAPI circuit regulator supply [16]

#### 4.4 Runway Lighting Control

##### 4.4.1 Tower Control Panel

Runway lighting control is done from the computer in the tower. Constant current regulator (Figure 14) in the transformer building is controlled by the tower.



Figure 14. Constant current regulator in transformer building

Constant current regulators also feeds the runway circuit as shown in Figure 15. Adnan Menderes Airports, Ataturk Airport and some new airport controls are provided by smart relay box that called I/O Box.

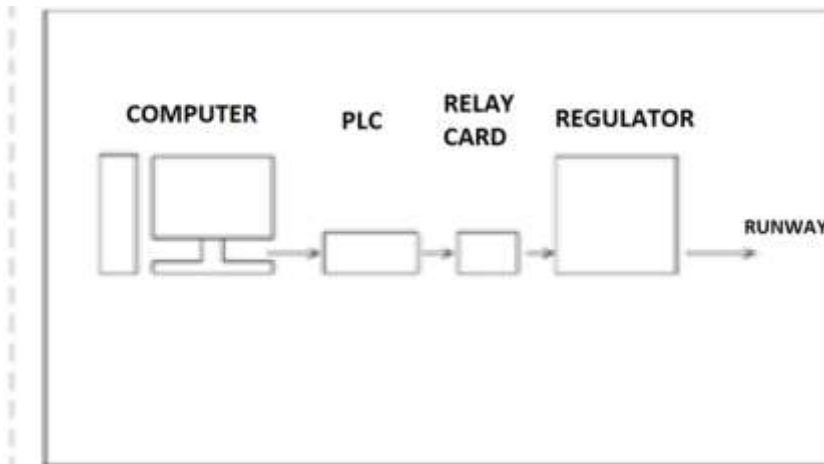


Figure 15. runway circuit connection of constant current regulators [16]

Control Monitor as shown in Figure 16 is the tower equipment to control the visual lighting systemsuch as runway lighting, rotating Beacon, mânia lighting, apron lighting, wind cone and wind direction indicator "wind T".



Figure 16. Erzincan airport display of the monitor control lighting equipment except runway

Control Board consist of two part; monitor and command buttons the other part of the key located. Monitor section; runway, taxi ways (Figure 17), places where the approach path and apron, runway end, threshold, runway edge (Figure 18), papi (Figure 19), fast output axis lights, Beacon, mânia, apron lights, wind cone and wind direction indicator is included as symbolic.



Figure 17. The commissioning of Taxiway lighting system using the Control screen



Figure 18. Commissioning of the runway edge lighting system using the control screen(yellow parts)



Figure 19. Commissioning of the PAPI system using the control screen

Tower operator can be run separately the system by controlling each of the remote control, buttons, and switches. The operator can easily see which of the device and the system is activated with the lighting of the icons mimic diagram on the monitor.

As some major airports at the Erzincan airport command control is via the SCADA system with touch-screen monitor rather than control board.

#### 4.4.2 Regulator that regulates the runway lighting control Using the PLC with the SCADA system

Interface on the left side in Figure 20 comprises the control of the runway and the right interface comprises control of taxiway to be used as runway in an emergency. User choice is primarily the direction of the runway(29 or 11).After the runway direction is selected, If user choose “DAY” from the user interface, it turns on light that need to be active during the day.If you select the Night (NIGHT) mode is activated lights should be active at night.If there are user requirements can also control the lights outside day and night modes.



Figure 20. Using the PLC via the SCADA Runway Lighting Control Screen belong Erzincan Airport

## 5. Discussion and Conclusion

In the study, Erzincan airport runway lighting and illumination systems were examined and are given extensive information about these lighting elements and the control systems. With the PLC and SCADA system, Erzincan airport rather than turn on the lights of runway lighting system one by one, all the light from the system at the same time opening is provided in one motion. Similarly formed a “DAY” mode of the system, and only the part that needs to be commissioned during the day of the runway lights are provided in this way. Also light intensity and light control is provided in a stable manner by using PLC and SCADA of the lighting systems. Due to the rapid opening and closing of the runway lighting system manually, sudden and extreme load on the system may occur. In these adverse conditions, can bring a harmonic occurs due to active cutter and insurance. Possible problems been prevented with the use of PLC and SCADA.

When activated human factor errors, such as incorrect opening and closing the lighting system it is dangerous for aircraft landing and take-off. Study carried out in the system by maintaining control with PLC has prevented such negativity. Especially in the winter in moments of low visibility daytime use of the lighting system may be more effective than the use of the marking system. Lighting elements of the system must be more effective in conditions like this. These problems have been overcome by dimming the light and turning into headlight.

As it is seen, through the use of PLC and SCADA lighting system; the light level control is provided, the power system harmonic prevented, time saving achieved and errors due to human factors was tried to eliminate as much as possible.

## References

- [1] T.C. Ulaştırma Denizcilik ve Haberleşme Bakanlığı Yayınları – 16, ‘Ulaştırma Denizcilik ve Haberleşme Terimleri Sözlüğü’, ISBN: 978-975-493-031-3, 2012
- [2] DHMİ Genel Müdürlüğü Görevde Yükselme ve Unvan Değişikliği Yönetmeliği Çerçevesinde Gerçekleştirilen Elektrik Teknikerliği Ders Notları, 2015.
- [3] Airport Rotating Beacon, Flight Light Inc. <http://www.flightlight.com/index.html>, Erişimtarihi: 25.01.2016
- [4] Airport Beacon, Erişimtarihi: 25.01.2016, <http://www.americanflyers.net/>
- [5] Uluslar arası Sivil Havacılıkta Kullanılan Uluslar arası Standartlar ve Tavsiye Edilen Uygulamalar.SeyrüseferSistemleri: UluslararasıSivilHavacılıkTeşkilatı (ICAO) yayıları Annex-10 1. cilt.
- [6] AletliİnişSistemi, [https://tr.wikipedia.org/wiki/Aletli\\_ini%C5%9F\\_sistemi](https://tr.wikipedia.org/wiki/Aletli_ini%C5%9F_sistemi), Erişimtarihi: 25.01.2016,
- [7] ABD AirfelSolition, User Manual, ‘L-880 & L-881 PAPI, Style A Precision Approach Path Indicator (Voltage Powered)’, 2014.
- [8] DHMİ Genel Müdürlüğü İşletme Dairesi Başkanlığı Elektrik Müdürlüğü Özel Aydınlatma Sistemleri Ders Notları, 2015.
- [9] Instrument Procedures, Approach Lighting System, [http://code7700.com/approach\\_lighting\\_system.html](http://code7700.com/approach_lighting_system.html), Erişimtarihi: 25.01.2016.
- [10] Sivil Havacılık Genel Müdürlüğü Havaalanı Emniyet Standartları Talimatı (SHT-HES) (Rev 01)
- [11] Doug Nancarrow, **Aviation Business Asia Pacific**, ‘New runway safety lights installed at Sydney Airport’, 2012.
- [12] Incandescent Elevated Runway Edge Light, ADB Airfield Solutions, Data sheet, LLC 977 Gahanna Parkway Columbus, OH 43230 USA
- [13] IREL Inset Runway Edge Light, <http://www.cooperindustries.com/content/public/en.html>, Erişimtarihi: 25.01.2016,
- [14] William Charles Electric, Aviation, Erişimtarihi: 25.01.2016, <http://www.williamcharlesconstruction.com/Electric/Capabilities-Aviation.aspx>
- [15] International Civil Aviation Organization (ICAO) Annex 14 Part 1
- [16] Ardiç U. ‘Uçak İniş Kalkış Pisti Özel Aydınlatma Sistemlerinin Programlanabilir Mantık Denetleyicisi ve SCADA Programı ile Kontrolü’ Yüksek Lisans Tezi, Muğla, 2012.