Outline

Runway status lights or RWSL is a fully automatic, advisory safety system that is designed to reduce the number as well as severity of runway incursions. The main advantages of the runway status lights are that it increases the pilots or the vehicle operator's situational awareness by providing directly the occupation status of the runway. This is done through autonomous illumination of the in pavement lights on the runway or taxiways. The runway status light system uses a fused surveillance data that is processed through intricate state as well as safety logic to give commands to in- pavement lights. These systems can improve the crew and vehicle operators' situational awareness through accurate and timely indication of runway occupancy.

Runway Status Lights

Introduction:

Runway status lights or RWSL is a fully automatic, advisory safety system that is designed to reduce the number as well as severity of runway incursions thereby preventing accidents in the runway while not interfering with the operation at the airport. This device is designed to be compatible with the current procedures and comprises of runway entrance lights, takeoff hold lights and runway intersection lights (Runway Status Lights.2010).

The main advantages of the runway status lights are that it increases the pilots or the vehicle operator's situational awareness by providing directly the occupation status of the runway. This is done through autonomous illumination of the in pavement lights on the runway or taxiways. There are three types of runway status lights. The first among them is the runway entrance lights. This light is placed at the runway or taxiway intersections. They are visible for the pilots taxing towards the runway and also warn them that it is unsafe to enter or cross a runway because it will be or soon will be occupied by high speed traffic like aircraft landing and takeoff. The second type of lights is the takeoff hold lights. They are placed on the runways at the departure position and will be visible to the pilots in the position of takeoff. They warn the pilots if the runway is occupied by another aircraft or vehicle. **The third type consists of the runway intersection lights which are placed on runways approaching a runway or its intersection. They warn the pilots in takeoff or landing that the intersection ahead is safe or unsafe to enter or cross because of the existence of a conflict.**

The runway status lights depend upon the runway entrance lights, takeoff hold lights and the runway intersection lights. They maximize the effectiveness to prevent accidents in the runway. The concept of the operations of this apparatus relies on its ability to give warning to aircrafts approaching a dangerous situation on a runway.

Technology

The runway status light system uses a fused surveillance data that is processed through intricate state as well as safety logic to give commands to in- pavement lights to illuminate on the surfaces of the airport thereby providing safety information to all pilots who are using the runways of the airport.

The runway status light system uses the existing technology of the airport surveillance with conjunction with the highly advanced data fusion technique and state logic that would automatically drive the status lights on the surface of the airport. The runway status lights system has the knowledge of the location of each aircraft on the runway whether they are arriving or departure. This is done using information provided by the three diverse surveillance sources. They are primary radar return returns from the airport surface detection equipment, time difference of arrival multialteration utilizing interrogation and replies from the transponder equipped aircraft as well as vehicles and the terminal radars that are used for the air traffic controls. There exists a technical challenge in fusing the overabundance of the data that is provided by the ASR, ASDE and the multialteration. One of the major technical challenges in this area is to avoid multiple tracks for the same aircraft as well as to cope with the bias between positional data provided by the ASDE that senses the radar centroid and multialteration that senses the beacon antenna location. In addition

fusion must also deal with the practical problems that are associated when it is turned off or malfunctioning, miswired or transponders that are non compliant. Moreover it also has to deal with the fact that the multialteration system can output position that is estimated for both the desired transponder replies and unsolicited replies that are generated by other systems that use it.

The fusion techniques that can fairly deal with these problems are under development. Therefore as a consequence the runway lights system additional fusion techniques that is well beyond than what is actually accomplished prior to the receipt of all the interests' reports of surveillance. The RWSL fusion uses all the input sources that are available to create a clean system tracks which are finally processed through the light logic and state machine. The RWSL fusion clearly allows for system tracks that are to be generated from a surveillance source that is either single or multiple. This is for addressing the issue of malfunctions or the nonexistence of sensors or the other equipments.

An ideal example of this service is that the vehicles that operate on the runways are always not necessarily equipped with the transponders that are used to respond to multialteration interrogations or the aircraft which are mandatory to be set do not always have it turned on or functioning properly. Under such circumstances, the RWSL can use the primary radar returns unilaterally to create a RWSL system track that will be developed through the light logic. The RWSL system can also use the multialteration data single-handedly without the returns from the primary radar. This feature generates the flexibility of the RWSL system and is a valuable feature.

The process of RWSL safety logic accepts the fused surveillance, also determines the tracks operational statures and predicts the future likely behavior based on the current state. It also determines when and which of the lights should be illuminated. The location of the traffic and the dynamics associated with it determines this process of deciding when and which light should be illuminated.

Using the output data that is provided directly from the surveillance, fusion and the safety logic processes, the computer that is known as the light control computer communicates with the field lighting systems for activating as well as deactivating the lights that are installed in and around the runways. When these lights are illuminated they indicate the pilot the status of the runway (How it works. 2010).

Human factors

The main purpose of RWSL is to reduce the frequency as well as severity of runway incursions thereby runway accidents are prevented. The instrument increases the situational awareness of the pilot. It provides a direct indication to pilots when it is unsafe to cross or to enter a runway. THL's provides a direct indication to pilots when it is unsafe to get departed from a runway. This new technology would ensure giving an absolute warning capacity to the flight crews and ensures safe passages for the aircrafts in the ground.

RWSL requires certain operational requirements. RWSL should not interfere with the normal safe operations. It is required that RWSL should operate automatically for each operation. No controller action is required for this purpose. The REL's should accurately depict that it is quite unsafe to enter or cross moreover it should posses high speed target on the runway in order to turn red. The THL's should depict correctly that it is unsafe to take off. Normally THL's are directed towards the approach end of the runway. They should be visible to the pilots in the position of takeoff's

.departure or on the final approach to land. Moreover to be consistent with the REL's, the THL's are placed longitudinally along the central line of the runway.

An ATIS message is used to indicate when the THL's and the REL's are operational. It has to be remembered that turning off the lights does not constitute a clearance to cross, enter or to depart from a runway. If the THL's illuminate, the crew should remain in a position for takeoff. And if the takeoff roll has started and illuminated, the THL's are observed. The crew should stop the airplane and should notify the air traffic controller that the aircraft has stopped because of the lashing of red lights. . If aborting the take off is impractical, the crew should proceed according to their best judgment and safety. If the crew understands that the illuminated THL's indicate that the runway is unsafe then it should contact the air traffic controller at the earliest of opportunities.

If they are on short final and the red lights of the THL's are on, then the crews should inform the air traffic controller that they are going around because of the fact that the red lights are on. The human factor challenges of RWSL include training of pilots and vehicle operators to understand about the indication of illuminated lights, I.e. whether the lights indicate a hazard or not. But lights turning off never mean a clearance. Moreover it has to be ensured that RWSL lights are visible to all the crews and vehicle operators under al type of weather conditions and should be independent of their work load. It is also important to determine the temporal and special characteristics of the status lights. Last thing to consider is the locating of the lights for optimum usability and effectiveness at reduced runway incursions. The other important human factors are insuring no increase to the controller work load, integration of the use of the RWSL system with other related systems that is currently used in the surface like AMASS controller alerts and the LAHSO (Runway Status Lights (RWSL) Human Factors Update.2006).

The RWSL indications are an automatic back up for the air traffic clearances. All the pilots and the vehicle operators have given training to know about the meaning of illuminated red REL's and THL's. This technology is regarded as a promising technology for reducing runway incursions. The REL's and THL's do not directly interfere with the normal and safe operations. They do not have the potential to reduce runway incursions. The operational concepts of the RWSL are simple and straightforward. When a REL illuminate, it means that an airplane is landing or departing and when a THL illuminate, there must be an airplane on the runway.

The implementation of RWSL has been a success in the history of air traffic safety. In surveys conducted, pilots have expressed their satisfaction in the system. But they also expressed their confusions regarding operation of the system. One among the primary concerns was that a pilot would misconstrue a light turning from red to off as a clearance to either cross or enter a runway or to take off upon the extinguishment of the red flashing of REL's and THL's. However the best method that should be adopted in such situations by pilots is to detect the event through timing analysis. Analysis of the pilot feedback from time to time has indicated that these systems are well understood, effective and suitable therefore should be implemented (Kufner&Perkins.2009)

Introduction and implementation of RWSL has tremendously reduced the chances of runway incursions and accidents due to it in all airports of the world. For example in the US, according to the FAA administrator, runway incidents dropped 50% in 2009. It was the second consecutive year that the incident free occurrences were reported after the introduction of the RWSL. It has to be noted that in the year 2000, there were nearly sixty seven serious runway incursions. More and more airports in US are now equipped with this system due to its positive feedbacks. The federal aviation authority in the US has made its priority to reduce serious runway incursions in the airports. They

have introduced this system in all major airports. After the introduction, the number of accidents has dropped by more than 63% from the year 2000. Fewer incursions were reported recently but these were attributable to operational errors. Runway incursions were down by 6% in 2009 when compared to 2008.

In the US, it is estimated that more than fifty million take offs and landings are made each year. These operations are handled by about fifteen thousand staff at the airports. Moreover hundreds and thousands of individuals of individuals drive vehicles on airport grounds. The increased number does not mean that there is no way to reduce the incursions on the runway. The safety of the runways is the joint responsibility of pilots, controllers and vehicle drivers. Equipments like the RWSL helps to prevent accidents but education and situational awareness is the most important aspect. RWSL helps to achieve these objectives if proper education is given to these persons in understanding and handling them (Previous post. 2010).

Implementation:

The primary means that is offered by RWSL is the reduction of Accident through runway incursions. This is achieved through indications given to pilots and vehicle operators that a runway is safe or unsafe to travel. Requirement of direct pilot and vehicle operator notifications is necessary because surface surveillance and air traffic control tools cannot alone monitor the situation effectively. The RWSL displays critical time sensitive safety information directly to the pilots as well as vehicle operators in quick time thereby it requires less time for them to avert from dangerous situations.

The RWSL software detects the presence as well as motion of airplanes and vehicles on or near the runways. They assess any possible conflicts with the other surface traffics. The system turns the red light off automatically when the runway is no longer unsafe.

The peculiarity of this system is that it does not increase the existing load unnecessarily or decrease the capacity of the airport. It works in concert with the existing systems that are used for runway safety. It is not necessary for the controllers of the air traffic safety to closely monitor the lights. The lights are driven automatically and the ground clearance safety system does not have anything special to do in this regard. The lights of the system are driven automatically using computer processing of integrated surface and terminal surveillance information's that are collected by the system (Federal Aviation Administration Runway Status Lights. 2008).

After its implementation in all major airports around the globe, RWSL has proved its worth. Moreover continuous research has also taken place in this area to improve the existing models. In 2002, a project was planned in US with the objective of determining the level of RWSL performance with the existing surface surveillance technology. Two approaches to the implementation of RWSL performance was to be evaluated. One approach was the ASDE-X technology as an underlying RWSL surface surveillance source. The second approach derived RWSL functionality from the AMASS (Runway Status Light System (RWSL) Operational Evaluation. 2005).

The performance of the RWSL system can be assessed in many ways. The key analysis elements include the number and rates of occurrence of anomalous lights. The anomalies are classified into three groups. They are missed detections or MD where the status lights off when they should be in a position of on. False activations or FA when the status lights are on when it should be off. And last

but not the least, Interference or I where the status lights on and interfering with the safe traffic flow. Comparisons of theses anomalies with established thresholds will definitely provide an insight into the RWSL systems technical performance. It has to be noted that nearly all type of anomalies are direct results of the surveillance problems and does not reflect the logical errors in the RWSL safety logic. Continuous development within the fusion processing of the system and improvement of the existing as well as future surveillance will help to build an efficient system in the future. Along with this the feedbacks from human factors associated with this system, especially the pilots should also be considered with high importance for the development (Results from operational evaluations.2010).

Studies undertaken in the area of airport safety have highlighted the importance of implementing RWSL in airports. RWSL has in fact demonstrated that it is highly compatible with the high tempo of air traffic control operations. It has received favorable response from the controllers. And it is estimated that at least seventy percentage of the runway incursions a\can be reduced through the implementation of thus system. Moreover many documented saves were attributable to RWSL in many airports. However some suggested improvements in this area include suppress light activations due to the taxing of aircraft on runways, suppress light activation due to clutter included by rains and to make lights dimmer at night. If these are dealt into, no doubt this could be a life saving apparatus.

In a study conducted on pilots by the FAA in 2009, almost 93% agreed about comprehension of the system, 90% on acceptance, 89% on effectiveness and 92% on suitability of the system (Operational Evaluation Experience.2009). The RWSL concept is designed to work in all weather conditions. These work automatically to provide direct indications to pilots about the status of runways. The system works in a non interfering manner with par with the air traffic controlling operations. The REL, THL and RIL deactivation is timed in such a way to operate in a non interfering manner with the air traffic operations in an airport. REL's are deactivated prior to a high speed crossing through an intersection.

The THL's are deactivated just before the blocking or crossing traffic. RIL's are done in the same way as the REL's. RWSL has been introduced in different airports after successful passing of different tests like engineering test, software test, shadow operations test, parallel tests etc. the air traffic controllers are given rigorous training to learn the different aspects of the system. Their training includes overview of the RWSL concept, how to change the intensity of the RWSL, how to input comments using comment field on the display of the RWSL and; lastly what to do if the system is not working properly (Randazzo.& McCann..2007).

Conclusion:

The primary objective of the RWSL system is to reduce the accidents occur in the runway through incursions of aircrafts and vehicles. These are advisory systems and do not interfere in the normal, safe and efficient operations of the airport. These systems can improve the crew and vehicle operators' situational awareness through accurate and timely indication of runway occupancy. The RWSL provides advisory services in all the situations. However its advisory indications should not be treated as an ATC clearance. Challenges that are associated with human factors in such systems were that of understanding the illuminated red lights used for raising situational awareness. It has to be understood that runway lights turning from red to off never imply a clearance. Standardization of the concept that red means stop would in fact increase the effectiveness of such system. All human

factor assessment in this regard has to done periodical so that errors and misunderstanding could be cleared quickly (Kufner&Perkins.2009)