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DISCOVERY HISTORY OF SAFE DESIGNS OF NUCLEAR REACTORS AS A SUBJECT OF TECHNICAL SCIENCES

INTRODUCTION

A nuclear reactor is a device that initiates and controls chain reaction. This can be linked to the operation of a boiler as used in thermal power plants. The fuel used for the nuclear reactor is mainly the uranium fuel. In history, researches have come a long way to develop this fuel in such a way to make maximum use of it. The uranium is placed in pellets and designed to be fixed into the core of the reactor. The fuel is burnt to generate heat which through the steam generator and turning the turbines to produce electricity. Notably, the basic use of the nuclear reactor in a Nuclear Power Plant (NPP) is to produce electricity, commercially. Currently, there are about 450 nuclear reactors in operation worldwide, approximately in thirty countries. The basic designed function of the nuclear reactor is to control reactivity, then cools down the fuel after it undergoes chain reaction [1].

ACHIEVING SAFETY

Safety is a requirement for the reason of protecting lives and the environment in every capacity. To achieve safety in the nuclear reactor designed, researchers and engineers considers the following factors [2],

I. Siting of a nuclear power plant
II. Transporting of radioactive materials
III. Operations of the reactor itself
IV. Management of radioactive waste

Historically nuclear safety designed was triggered by firstly, the April 1986 Chernobyl nuclear power plant disaster in the then Soviet Ukraine. Secondly, the March 2011 Fukushima Daiichi nuclear accident in Japan. After these two major disasters, the IAEA, researchers and scientists took interest in trying to find the cause of the disaster and the best remedy to prevent any further accidents [3]. The basic ideas were to improve upon the previous designs to achieve such an aim. This motivated scientists more to intensify their research into the generations of NPP. The nuclear accidents put some kind of fear in a lot of people. This was because, before these two major accidents, in 1970, people already assumed a high risk of accidents to occur from the containment buildings. Later in the same year, detailed research and analyses were

done to prove otherwise. The Fukushima accident report confirmed research done in 1970. That, with its triple melt down of the reactor core, no fatalities or serious radiation doses were found in anyone. Over 200 employees were assigned to work on the accident site to lessen the effects of the accident. If serious radiation doses were reported, this exercise would not have been done. However, improvement on the design is still necessary

GENERATIONS OF NUCLEAR POWER PLANTS

This refers to the technological development of nuclear reactors. There are four classifications of the nuclear power plant generation. It is from generation I to Generation IV. The relevance of these generations is to design, build and operate a nuclear power plant with free or the acceptable minimum accident that could occur in any industry.

Generation I

These were the prototype developed in the 1950s. We can call them the pioneers of reactors. Samples made are the shippingport made in 1957, the Dressden-1 and the colder Hall.

Generation II

An improvement on the previous generation was to have reactors that can be used for commercial purposes. The lifespan was designed to be forty years the pressure water reactor (PWR), boiling water reactor (BWR), the RMBK and Water Water Energy reactor (VVER) were among the reactors developed.

Generation III

An evolution from generation II gave birth to generation III. They have simple but with vigorous structural designs. The fuel technology, safety systems and the thermal efficiency were the improved areas from generation II. Efficient use of the fuel (high burn-up) reduces the nuclear fuel. Its lifespan is up to 60 years.

Generation IV

These are the reactors deeply researched and designed based on the coolant used. Due to the fact that there are anti-nuclear bodies and organizations in the world, the nuclear power plant must be accident free. The IAEA in its quest has put tremendous measures to control any country willing to embark on NPP operations. These generational reactors are proposed to start by 2030. It is believed that most countries have advanced in building the power plant [4]

Conclusion

In history, an accumulated reactor years in about 36 different countries is 18,500 years [5]. It is of no surprise that within these years only two major accidents have occurred. The Chenobyl and Fukushima disasters.

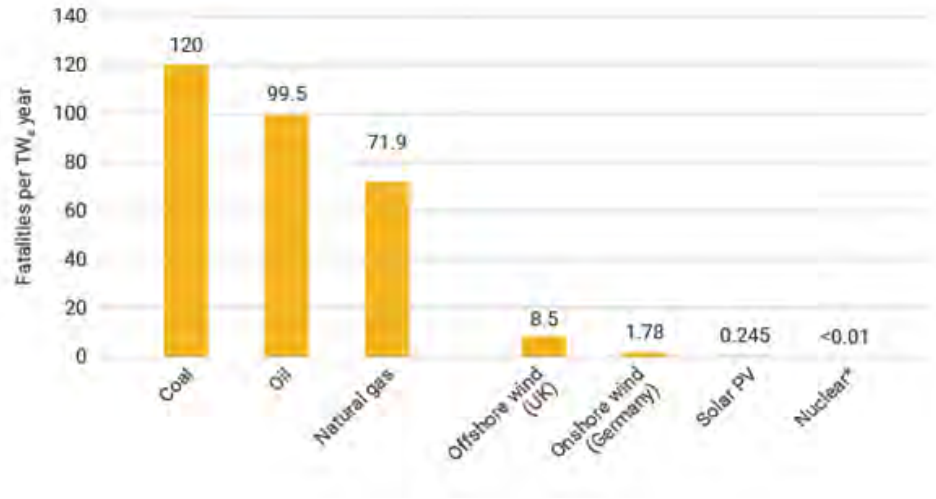

Fig.1. Deaths from energy-related accidents per unit of electricity

This graph from Pasul Scherrer institute shows how fatalities have occurred in different power plants. Out of the lot, nuclear received the lowest fatalities [6]. This is because, the new reactors designed have sensors which automatically shuts down the plant in case there are excessive chain reaction within the reactor core, which may cause accident. Again, the newest designs improved on minimizing waste, utilizing the fuel and minimum cost in mounting the NPP. It is this situation that contributes to the development of such qualities of a «modern engineer as the ability to innovate» [7, C. 268].

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DEPLOYING INDUSTRIAL INTERNET OF THINGS (IIOT) IN NEWLY-BUILT NUCLEAR POWER PLANTS

Abstract

The Industrial Internet of Things (IIOT) evolution made IIOT deployable in nuclear power plants for remote access and monitoring operations. The deployment will be technically effective and economical when deployed during the construction of the NPP than on existing NPPs. Most existing NPPs were constructed prior to the digitalization era, so they do not provide the data visibility IOT needs to work. Deployment of IOT sensors at the design and construction stage will supply the operating system with raw data transmitted to the monitoring system for necessary predictions in real-time.

Index Terms

Industrial Internet of Things, Smart Nuclear Power Plan System, Safety and Security, Cyber Risks and Security

1. Introduction

The adoption of the Internet of Things (IOT) resulted in the rapid growth of connected objects in recent years. In the next 20yrs, there will be an estimated 30 billion IOT connections in the Universe, averaging to 4 devices per person [1]. IOTs are deployable in various applications such as Smart Houses, Smart Cities, Smart Health, and Smart Nuclear Power Plants.

2. Motivation and Contribution

IOT is an approach that links the internet with sensors and working devices for an all-internet protocol (IP) based architecture [2]. However, few research works are found in existing literature addressing the applications of IOT