S.2.2 Application of preventive protection in an Oil Basement in China

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Abstract

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Application of preventive protection in an Oil Basement in China Zhengyu, Le SIPOPEC. Ningbo, Zhejiang, P.R. China Abstract — One of the largest crude-oil basements in China is placed in Zhejiang province, facing the East China Sea, a very populated area and with a high flash density. Several accidents caused by lightning have led the company to introduce preventive protection within its security plan, in order to protect the infrastructures, equipment, workers in open areas, raw materials, etc. With the purpose of having an early and trustful alarm of the local storm risk, the basement has been provided with thunderstorm warning systems which detectors measure the electric field (Class I detectors according to EN 50536). This paper describes the risk analysis made by the company, its preventive protection measures and actions as well as the results of the two thunderstorm warning systems installed in the company, both with electric field measuring detectors although using different technologies (with and without mobile parts). Keywords— national oil basement; preventive protection; electric field measuring detector; full electronic sensor I. INTRODUCTION Lightning is one of the most severe weather hazards. With the development of modern science and technology, the losses on property, economy, and even human life, have been increased due to lightning accidents. Sinopec, the biggest public company in China, has suffered several accidents caused by lightning strikes. In August, 1989, lightning strikes caused a fire, and followed by severe explosion in Sinopec Huangdao Oil Depot Basement. During this accident, 36,000 tons of crude oil was burned, with 630 tones flew into the ocean, 74 people were injured, and 19 people died.[1] As well, one of the biggest national crude oil depot basements of Sinopec, located in South-east coast of China, has faced serious threats from lightning strikes in the last years. In 2007, the first year in operation, lightning strikes have lit the flammable gas inside the seal-ring of one oil tank, and caused a fire[2]. After that, this important national oil basement was endangered by thunderstorms every year. II. RISK ANALYSIS After analyzing the area, there are mainly 4 facts, which put this oil basement in high risk of lightning damages: A. Location: It was located at the coast of Zhejiang Province, South-east China. The average thunderstorm days is around 45 per year, belonging to high-risk area (see figure 1). B. Environment: This national oil basement is placed on coastal land, within an open area. There are no higher buildings or structures nearby. That is to say, it’s in a humid, corrosive, and relatively isolated environment. C. Containers: There are tens of external floating roof tanks, and over 5,000,000m3 crude oil contained within 1.5km2 area. Metal structure is easy to catch lightning, and flammable material is sensitive to fires (see figure 2). D. Volatile Gas: External floating roof tank is uncovered and exposed to open air, unable to prevent volatile and flammable gas filling in the gap between roof and tank enclosure, or over the roof. It’s possible to induce secondary lightning effects even primary lightning are led to the ground through provided path. Figure 3: External floating roof oil tank III. PREVENTIVE PROTECTION A. Risk control In order to evaluate the advisability of the use of Thunderstorm Warning System, firstly, the hazardous situations were identified. The EN 50536 names these situations[4]: TABLE I: Identification of hazardous situations [4] No. Situation 1 People in open areas without an appropriated lightning protected shelter available (according to EN
Preventive actions Preventive protection means having information in advance that allows the user to start temporary preventive actions before the storm begins. These actions will be finished after the storm. Some preventive actions have been put into Safety Management Provisions, which must be taken after detecting thunderstorm risks: • Evacuate people in open area; • End/postpone high risk activities, such as load or unload oil operation; • Alert related and responsible personnel; • Fire control standby. Furthermore, an automatic nitrogen charging system is planned to be constructed, which will fill flame retardant nitrogen on the roof of tank automatically, after lightning strikes risks are determinate. Thus, having trustful and timely information about the risk conditions of a storm is the primary condition to take all temporary measures of above. C. Solution adopted In order to have this information the installation of a Class I detector was decided. According to the EN 50536 these detectors allow to warn the risk of a storm since the first thunderstorm phase. Since 2011, an electric field measuring detector, by using traditional "field mill" sensor, was installed to protect this national oil basement. An electric field measuring sensor is capable of measuring continuously the electric field. Therefore, it can measure small variations or increments of the electrostatic field, caused by the approaching of a storm or by its formation over the sensor. A lightning strike is not necessary in order to detect storm activity. This is suitable for this national oil basement which needs local thunderstorm warning information with sufficient time in advance. IV. INCONVENIENCE OF FIELD MILLS AND SOLUTION The use of the field-mill is able to provide effective information for preventive protection at the beginning. But its performance has worsened since the second year, and even not warning about existing thunderstorm in several occasions. This is mainly because field-mill is using a rotary motor that must work 24hours a day. Thus, the storm detector device might be affected by several facts as below: 1) The motor stops due to malfunction, damage, or obstruction. Then, the sensor becomes out of service; 2) Mobile parts are blocked and out of service due to objects, insects, frost, ice etc.; 3) Exposed motor is covered by dust, abrasion, or corroded, then led to accuracy decreasing. In order to solve this inconvenience caused by the field mill, a Storm Detector by static electric field measurements without mobile elements has been installed. It's applied with FCES (Field-Controlled Electrometric Sensor) technology, regarded as an alternative solution and more suitable device for this national oil basement. V. PERFORMANCE New storm detector with FCES sensor was installed in August, 2013. And, within one month, all 6 thunderstorms were recorded and warned. This paper chooses one thunderstorm on August 22nd , 2013, and compare to manual records, and field mill’s records, which was maintained and repaired. Figure 3: August 22nd lightning location A. Compare to manual records Before 23:00, according to manual records, there is no lightning activity. In the Figure 4, the atmospheric field is fluctuated within 600V/m; 19:12 00:00 04:48 09:36 14:24 19:12 00:00 -20000 -15000 -10000 -5000 0 5000 10000 15000 20000 V/m Before Storm August 22th Figure 4: E-field graph before 23:00 The first flash was recorded at around 23:20 manually, and thunderstorm lasted to 00:30. The variation trend of electrical field is shown in figure 5: 23:09 23:13 23:16 23:24 23:34 23:38 23:45 23:52 24:00 00:07 20000 -10000 -5000 0 5000 10000 15000 20000 V/m Storm August 22th Figure 5: E-field graph between 23:00 to 00:30 TABLE VI: Records of sensor and manual work Time Sensor records Manual records I 23:00 to 23:10 e-field increased gradually No lightning appeared II 23:10 to 23:20 e-field increased rapidly Alert alarm activated III 23:21 e-field increased to 9000V/m First flash recorded IV 23:21 to 00:30 e-field oscillated rapidly, maximum to 18848v/m Numbers of lightning strikes appeared V After 00:30 e-field decreased under 1000v/m, and graded into normal None lightning activity was recorded after that From Table 6, it clearly shows that all data recorded by FCES sensor matched with the manual records, and FCES sensor recorded electrical field increasing, and sent out alarm even lightning strike had not appeared yet. VI. COMPARE FIELD MILLS RECORDS The field mill and FCES detector are installed on the same roof, with distance no longer than 20 meters. 23:38:07 23:42:04 23:46:13 23:50:19 23:54:28 23:59:02 20000 -15000 -10000 -5000 0 5000 10000 15000 20000 AtStormV.02 V/m 22/08/2013 23:34 23:36 23:39 23:42 23:45 23:48 23:51 23:54 23:57 24:00 -6 0 6 12 Field Mill Kv/m Figure 6: Graph of Field Mill and FCES sensor In the Figure 6, electrical field recorded by field mill and FCES Detector appears with similar shock trends. Both detectors recorded the thunderstorm efficiently. VII. CONCLUSIONS A risk analysis determined that the installation of a preventive protection was highly recommended for an Oil Basement in China. The installation of Class I detectors allowed to start preventive actions before the storm activity in order to avoid damage from lightning. Two technologies of Class I detectors were installed, in the placement and their performance have been analyzed in this paper, showing that both sensors give similar results, but the FCES sensor solves the inconvenience of mobile parts. REFERENCES [1] Ping Huang, Xinming Qian, Wenlei Sun, Safety influence of lightning- induced secondary spark discharge on oil tanks area, ISBN 978-1-61284- 667-5 [2] China Fire-control Online,