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Developing an Alarm Rationalization Process to Reduce Flare in an Oil and Gas Facility.

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ABSTRACT

There was a Government of Nigeria requirement that gas flaring in the country must be reduced to the barest minimum in response to environment impact on local communities and she stipulated considerable fines for defaulters of the Policy. Hence an Associated Gas (AG) Plant for Gas gathering facility was built to reduce to a barest minimum flared gas produced by an Oil & Gas gathering Station in Nigeria. The function of the Gas Plant was to gather low pressure associated gas, process and compress it, and send the product to a liquefied Natural Gas (NLG) Plant at Bonny, Delta region of Nigeria. However the automation & Control requirements of the AG plant during design & construction lead to an increase in the number of alarms generated and created difficulties in managing them during production processes, resulting in frequent Plant outage. This paper presents work done to rationalize alarms in an AG Plant which lead to financial gains for the company (more product to LNG and less fines to the Government on flaring). The main objective of the project was to reduce the number of alarms to barest minimum; which will directly reduce deferment in production that in the past happens whenever the AG plant is not available.
This project has shown that it is possible to develop automation solutions that meet core safety and business requirements.

Keywords: Alarm rationalization, oil and gas facility, flare reduction.

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1. INTRODUCTION

This paper introduces a project undertaken to meet safety, environmental and business need of an Oil & Gas company. First the basic Flow Station (FS) is illustrated to explain the process of the Plant and this is followed by showing the function of Associated Gas (AG) gathering and processing. Once the gas gathering and processing is understood, it will be easy to see how alarm figures increased and how increased alarm figures (Dick Perry, 2000) affected the availability of the AG Plant (Johannes Koene and Hiranmayee Vedam, 2000).

The FS can operate independent of the AG but that will lead to gas flaring and payment of hefty fines to the Federal Government. Therefore to make optimum gain from the Oil & Gas operation, the AG plant must have a good reliability figure and operate round the clock (A. Nochur, H. Vedam, & J. Koene, 2001); which is not possible with operator bombarded with too many alarms (Edward Marszal, 2003). The first port of call is the Flow Station and how oil and gas are processed in the plant.

The AW Flow Station is illustrated in figure 1 on the next page . The AW Flowstation which was commissioned in 1992, is a standard single bank station with a nominal capacity of 30,000 barrels of oil per day (30 Mbpd) and 50, 000,000 standard cubic feet of associated gas per day (50 MMscfd).

Crude from seven Oil Wells (not shown in figure 1) flows to the station through the inlet manifold. At the inlet manifold, it is directed to one of the headers; XHP (Extra High Pressure), HP (High Pressure) or LP (Low Pressure) line depending on the pressure regime or Test header for well testing. The XHP header feeds the XHP separator operating at a static pressure of 28 barg, HP header and the liquid discharge of XHP separator, feeds the HP separator operating at a static pressure of 12 barg, while the LP separator operating at a static pressure of 3 barg is fed by fluid from low pressure wells together with liquid from the HP separator. The LP separator liquid output goes to the surge vessel (operating at a static pressure of 0.3 barg).

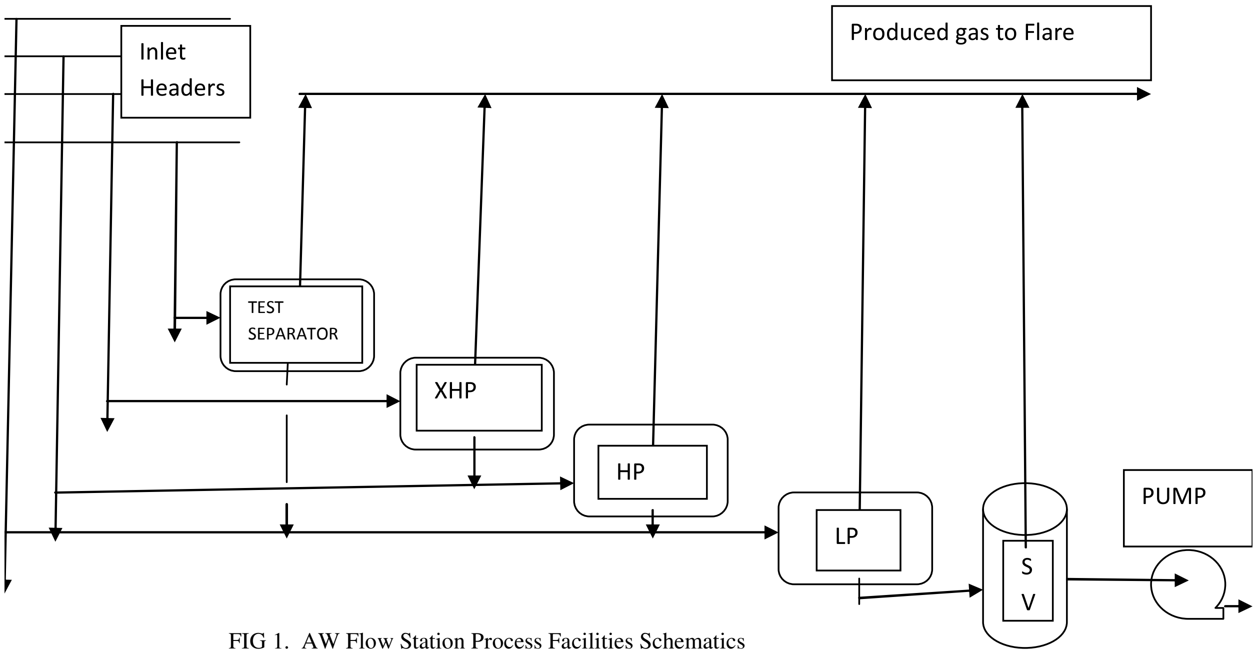

FIG 1. AW Flow Station Process Facilities Schematics

At the surge vessel, the liquid is stabilised. Produced liquids (oil and water) are pumped into a 6'' x 2.4 km delivery line by Emsco D225 reciprocating pumps driven by Caterpillar G342 gas engines. The major proportion of associated gas production is flared through two of the three installed 30" horizontal flares, with a small amount being used for instrument gas and fuel for the generator (located in the gas plant) and export pumps. Electrical power for the plant is supplied from the generator sets at the gas plant.

2. AW ASSOCIATED GAS PLANT

The Nigerian Government enacted a new law to reduce to the barest minimum, gas flaring and the associated environmental issues and hence the associated gas flared attracted heavy fines. The solution was to build an associated gas plant illustrated in figure 2.

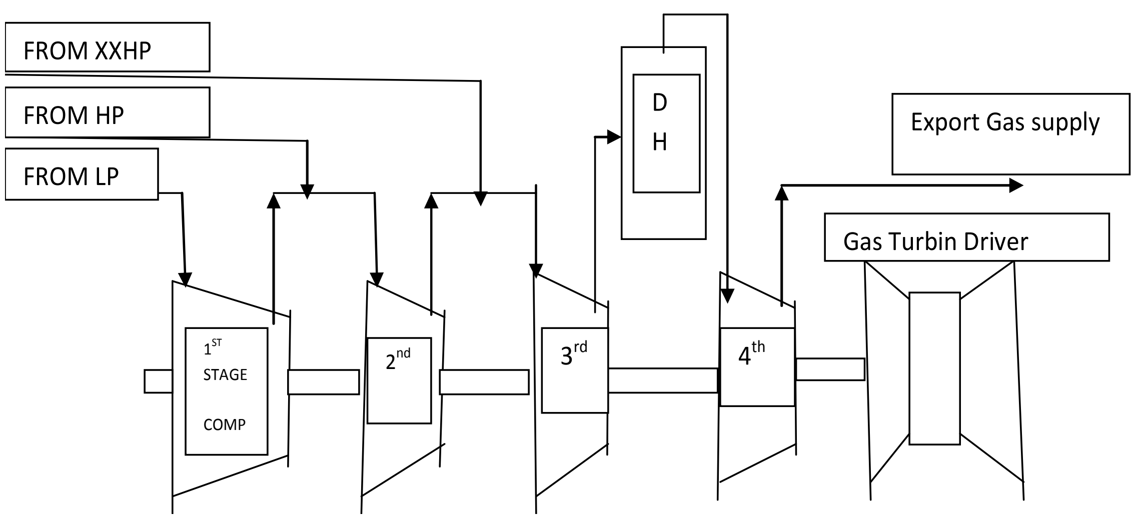

Fig. 2: AW Associated Gas Process Facilities Schematics

The 55 MMscfd nominal capacity AW AGG plant shown in figure 2, provides AG solution to the AW FS. The facility comprises of a single train, 4 stage compressor, which compresses gas from about 3.0 bara to 135 bara, and a Dehydration / Regeneration (DH) system. The Plant was commissioned in November 2006 and was required to take care of the associated gas produced by the AW Flowstation.

The 1st stage compressor gas handling capacity is limited to a minimum of 3.95 and maximum of 7.07 MMscfd at the expected case speed of 9198 rpm. The 2nd stage compressor gas handling capacity is limited to a minimum of 28.2 and maximum of 47.7 MMscfd at the expected case speed of 9198 rpm. The stage capacity is however limited to 40 MMscfd by the shaft power available to the 2nd stage. Based on shaft power available to 3rd and 4th stage, the compressors can do 68 MMscfd each. However the 4th stage suction scrubber gas outlet nozzle can handle only 58 MMscfd. This puts the maximum capacity of the 3rd and 4th stage to 58 MMscfd each.

2.1 Control System

With reference to figure 2 showing all the AG gas facilities, it is apparent that a distributed control system (DCS) is required to make sure that the Compressor and its driver function are operated as designed in a safe manner. The AW control system was split into three units namely; (i) Basic Control, (ii) Safety System and (iii) Fire & Gas respectively. Each of the unit mentioned above generates alarm to indicate when the basic process parameter is operated outside the operating envelope. For example, an instrument labelled 311-LICA-001 performs level control with alarms such as low or high attached to the performance. Hence a table (so called RAT list) was produced which list all the instruments and their ranges, unit of measurement, alarm settings and their tag numbers.

2.2 Alarm rationalization

From the Process Engineering Flow Scheme (PEFS), Cause and Effect (C&E) Diagram, and RAT List, alarms were implemented in the DCS, and Safety Systems. For example, in the case of AW Compressor illustrated in figure 2, a Scrubber installed in the inlet gas line will have Low Low(LL), Low(L), High(H), and High High(HH) alarm settings to warn the operator when the process variable (liquid level in the scrubber) is operating outside the required operating envelope. This is essential because wet gas inlet into the compressor can damage the machine. However during Front End Engineering Design (FEED), Detailed Engineering Design (DED), construction and commissioning of AW gas plant, the number of alarms grew exponentially (E.H. Bristol, 1999). At the end of hand over to Operations, the operator was left with too many alarms (Donald Campbell Brown & Manus O'Donnell, 2002) which made it difficult to respond to critical alarms (W.H. Smith, C.R. Howard, & A.G. Foord, 2003). This in turn made the AW plant to have low availability, which directly affected the production of oil and gas. The failure of AW plant means that all the gas produced in the Flowstation have to be flared and if the allowable quantity is exceeded, the Flowstation has to be tripped and production stopped.

2.3 Gains from Alarm rationalization

To solve the problem of production loss (Yoshitaka Yuki & Jim Parks, 1999) due to frequent Plant trips, a Team was set up to do alarm rationalization (Yoshitaka Yuki & Kimikazu Takahashi , 1999) on the AW compressor station. The result of the studies is illustrated below:

a. Tags changed from Critical to Standard list = 3
b. Tags changed from Critical to Alert list = 74
c. Tags changed from Critical to Event Logs = 44
d. Tags changed from Standard to Critical list = 2

Total number of tags changed as a result of the studies was 123 and this resulted in the reduction of the alarm rates from 300 to 12. This in turn has been shown to increase the plant availability from 50 to 85 % and indirectly increase oil & gas production by at least 35% when fully implemented. In terms of the Flowstation production an increase of 35% production will result in 35% of 30,000 barrels of oil per day = 10,500 barrels of oil per day. In terms of money of the day, this is equivalent to US$ 1,050,000 (crude oil price at the time of this project was US$100 per barrel). In addition, the gas which would have been flared will amount to 35% of 50,000,000 standard cubic gas per day = 17,500,000 scf of gas each day. If one converts the gas lost into equivalent money of the day, at 1/10 US$ per standard cubic gas, then it is US$1,750,000. The bottom line is that this project yielded more than two million US$ equivalent per day by simple applying alarm rationalization process (Donald Campbell Brown & Manus O'Donnell, 2002)

4. CONCLUSION

This paper has presented work done to rationalize alarms in an Associated Gas Plant which resulted in reducing alarm rate from 300 to 12. It is expected that when fully implemented the project will result in production increase of about 35% which in turn will yield about two million equivalent US dollars for the company. The project has shown that it is possible to develop automation solutions that meet not just core engineering requirement but both safety and business needs.

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