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## ASW ENGINEERING MANAGEMENT CONSULTANTS

Date: October 19, 2011

To: The SCE ISP evaluation team  
Southern California Edison

From: Dennis Rowan PE, Mark Hinrichs, and Ervin Alba  
ASW Engineering Management Consultants

Re: Investigations of Energy Efficiency Measures and Industry Standard Practice (ISP)  
[New Load Oilfield Water Injector Pumps]

After reviewing the Oil and Gas Production Energy Efficiency Program project feasibility study, supporting documents, and expert opinions, pertaining to oilfield water injection pump systems, such as the system described in the project feasibility study, ASW recommends that SCE considers that this technology application is not Industry Standard Practice (ISP).

### **PROJECT DISCUSSION**

Fluid from California oil wells contains large amounts of water which the oil company must extract from their raw material so that only usable material is processed. Once the water is separated from the oil, it must be disposed of by doing one of the following: re-injecting the water into the reservoir, or transporting the water to a treatment facility for treatment and disposal.

The oil company is in the process of installing a new injection facility that will consist of four pumps that are each driven by 1,250 hp induction motors for their injection pump system. It is projected that facility production will increase over the next five years and the customer, will see an average demand savings of 405 kW/year over the next five years.

Initially two out of four pumps will be running with one constant speed pump running at full capacity and the variable speed pump, controlled with a Variable Frequency Drive (VFD), will modulate as needed. As production and injection pump requirements increases, the other pumps, pumps three and four (constant speed pumps), will be brought online as needed. The VFD pump will continue to modulate the total flow rate of the pumping system which will result in energy savings. The alternative 'baseline' system uses a throttling valve to regulate the flow. This throttling method is presented in the feasibility study as the standard means of controlling flow in the absence of a VFD.

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### METHODOLOGY

ASW contacted the head of operations at a branch of a petroleum company. ASW asked the respondent what type of injection pumping systems they used in their production. He said that they used constant speed injection pumps. When asked whether he would consider the installation and use of VFDs on their injection pumping system, he replied that there were some applications where he could see the implementation and the use of VFDs useful in his industry, however, the constant speed pump is the more common technology that the industry tends to implement. The respondent indicated that the availability of incentives for the installation of VFDs for these injector pumps would be a significant factor in his decision as to whether or not he would implement the technology. The respondent was asked what the prevalence of multi pump installations was in his industry. He replied that they had multiple water injections pumps serving single well sights at their facility. He explained that they have pumps that build the pressure up to a certain level, and then, a different set of pumps are used to raise the pressure even more. The respondent was then asked if VFDs on water injection pumps applied more to new construction or retrofit construction. The respondent said that it can apply to both. However, there would be more opportunities for retrofit construction due to the fact that most of the water injection pumps in place do not contain VFDs. The respondent was asked whether VFDs on water injection pumps as a non ISP applied more to stand alone pumps or assisted pumps. The respondent stated that in their case it applied to assisted pumps. As he stated previously, they have multiple pumps that work together. The respondent was finally asked if his conclusion that VFDs on water injection pumps not being an ISP applied to the majority of pumps installed in a facility, or, whether it applied to the majority of the industry in general. He replied that it is based on the prevalence of water injection pumps with VFDs in a facility.

ASW contacted a facility operator at an energy company. ASW asked the facility operator if they were currently using injection pump systems in their production line and the facility operator confirmed that their facility does have injection pump systems as a part of their production equipment. According to the operator, the pumps in their injection systems are constant speed. However, they are currently working with a company that is installing VFDs on some of their pumps and in return the company is receiving incentives. The operator indicated that installation would depend on the application and if there is a need for VFDs. The operator noted that having VFDs on the pumps would be beneficial as it would result in less wear and tear on their equipment. The operator also noted that most of their equipment is small and their decision of whether to install VFDs would depend on the application and the economics.

ASW contacted a senior mechanical engineer working as a consultant for an engineering company's energy division; he also has extensive experience in the oil industry. ASW asked the engineer if he was familiar with water injection pumps. The respondent stated that he has visited facilities where water injection pumps were a part of their production line and he has knowledge of how they work. ASW asked the engineer if he felt the installation of VSDs on a water injection pump system was an industry standard practice, the respondent noted that it depended on the situation. Facilities that consistently have a high volume of production would not really benefit from using a VFD. When asked about his visits to oil production facilities and whether the majority of those facilities he visited had VFDs in their water injection pump systems he responded that it was not always the case that there were VFDs on the water injection pumps at facilities he has visited. The older facilities tended to have constant speed water injection pumps and facilities that had been updated or built within the last three or four years are facilities where the use of VFDs was more common. The respondent was asked what the prevalence of multi pump installations was in the oil industry. He stated that in his experience, one water injection pump served multiple wells. According to the respondent, water injection pumps have different characteristics, building up rejection pressure over time. In many cases water injection pumps are sized to handle as many as 6-7 wells. He explained that wells produce oil through the skimming of the top of the

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aquifer. The oil is located at the top of the water table. Injecting too much water into the well can result in the water table rising too high resulting in skimming less oil because you would then be skimming below the water surface where the oil concentration is lower. The respondent further explained that VFDs would be beneficial in this case to slow down the water injection pumps allowing the aquifer to be maintained at the proper level so that production can be maximized. The respondent was asked if VFDs on water injection pumps as a non ISP applied to new construction or retrofit construction. The respondent replied that it is difficult to tell but he would have to say it applied more to retrofit construction. Or maybe the answer should be that it applies to both. The respondent was then questioned whether VFDs on water injection pumps as a non ISP applied to stand alone pumps or assisted pumps. He replied if you were dealing with an enormous amount of fluid than big enough pumps are not found so parallel pumps would be used. He explained that usually there are 2 or 3 water injection pumps and this becomes too involved as the second and third pumps are usually stand by pumps. The reason for the stand by pumps is to ensure that if one pump fails you would have a back up pump because being unable to inject water into the system makes it impossible to acquire the oil. He further explained that upon inspection if you see more than one water injection pump serving the same system, the second pump is the pump on stand by. Typically only the first pump would be eligible for incentives. The respondent was finally asked if VFDs on water injection pumps as a non ISP applied to the majority of pumps installed in a facility or if it applied to the majority of the industry in general. The respondent replied that it would depend on the pump, for water injection or water disposal pumps, people are thinking how they can keep the system going. As pressure builds up on centrifugal systems, the curve must be adjusted because over time the put away volume increases and more water is produced than oil. This must be countered so that you do not have to add more water injection pumps to the system. Smaller systems use positive displacement pumps so pressure isn't a problem. Positive displacement pump pressure is fixed at the design pressure of the pump. There are two ways that you can alter the system flow that do not require the use of a VFD. For a centrifugal pump you can use a throttling valve and for a positive displacement pump you can use a recycle loop so that you do not blow a pumps motor. It just depends on the system a facility is using. Many companies use systems with VFDs because it is practical. The industry has become more aware of installing VFDs on water injection pumps, probably 20% of facilities but I can't say for certain because I have not done a survey. The respondent stated that he would have a difficult time saying VFDs on water injection pumps is a standard practice; it is just good engineering. VFDs on water injection pumps are becoming standard practice but are not standard practice yet. Incentive programs are assisting in this trend. Large companies using centrifugal or positive displacement pumps are heading to VFD technology on water injection pumps due to the availability of incentives.

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ASW presents the following matrix of factors for your consideration regarding the New Load Oil Field Injector Pumps VSD project:

**Table 1: Factors indicating Industry Standard Practice**

| <b>Factors Indicating Industry Standard Practice</b>                                                                                                                               | <b>Significance ( 1 – 3 )<br/>1=low, 3=high</b> | <b>Significance Explanation</b>                                                                                                        |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| Newer facilities are incorporating VFDs into their water injection pump systems                                                                                                    | 2                                               | The fact that the newer facilities tend to incorporate this technology into their designs is evidence of an industry standard practice |
| Due to wear and tear, equipment eventually needs to be updated/replaced and based on current trends, the newer industry is geared towards the use of VFDs on water injection pumps | 1                                               | This trend is an indication that the industry is transforming to this technology                                                       |

**Table 2: Factors indicating Non-Industry Standard Practice**

| <b>Factors Indicating Non-Industry Standard Practice</b>                                                                                         | <b>Significance ( 1 – 3 )<br/>1=low, 3=high</b> | <b>Significance Explanation</b>                                                                       |
|--------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|-------------------------------------------------------------------------------------------------------|
| Water injection pumps are typically sized for the production rates of the fields they serve.                                                     | 2                                               | Installing a VFD would not improve the efficiency of a properly sized unit                            |
| Industry representatives stated that the majority of water injection pumps are constant speed                                                    | 3                                               | Industry companies contacted are not currently using VFDs on water injection pumps                    |
| Company's profit is directly tied to the quantity of product produced/pumped minus expenses, main priority of any company is to increase profits | 2                                               | If the installation of VFDs was universally beneficial, then more companies would have them installed |

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The factors in Table 2 indicating the new load oilfield water injector pump project is not an Industry Standard Practice (ISP) outweigh the factors in Table 1 indicating the installation of VFDs on the new load oilfield water injector pump project is industry standard practice. Industry representatives contacted stated that many water injection pumps are not currently equipped with VFDs and that the availability of incentives is a significant factor in the industry's decision to install VFDs.

### CONCLUSIONS

After reviewing the Oil and Gas Production Energy Efficiency Program project feasibility study, supporting documents, and expert opinions, pertaining to oilfield water injection pump systems, such as the system described in the project feasibility study, ASW recommends that SCE considers that this technology application is not industry standard practice (ISP).