HIGH VOLTAGE INFRASTRUCTURE IN THE WATER SECTOR

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ABSTRACT

In recent years the power industry has made significant advancements in the identification and mitigation of hazards in high voltage installations, particularly in the areas of earthing and arc flash hazards. As the Water Sector's business focus is not on its high voltage and electrical assets, these assets are often installed and forgotten about. Recent studies and assessments at a number of water utilities throughout New Zealand and Australia have identified key risk areas that should be addressed, these include earthing of high voltage installations and risks associated with ageing assets.

In Australia there has recently been an increase in the number of projects and asset renewal programmes for HV installations in the water industry. The type of HV assets replaced and upgraded under these projects includes indoor switchgear, transformers, protection, earthing systems, overhead lines and power cables. Earthing assessments and upgrades have also been a key focus because earth fault currents can lead to dangerous touch voltages on any metallic surface in and around an HV installation.

This paper will discusses areas where key issues have been identified and recommendations on how asset owners can take a practical approach to identifying and mitigating key risk areas in their installations.

KEYWORDS

Health and Safety, asset renewals, infrastructure, hazard assessments, high voltage

1 INTRODUCTION

High voltage infrastructure is a common component in water utility installations. While the obvious hazard of direct electrocution associated with these installations is well understood, other hazards presented by high voltage (HV) installations have traditionally been less well understood. Over the last ten to twenty years the high voltage industry has made significant advancements in the identification and mitigation of hazards presented by HV installations. As a result of this, equipment and installation standards are now considerably safer than what they were previously. In particular, high voltage switchboards are now constructed to contain or safely vent arcing faults, and industry standards have advanced considerably for the assessment of arc flash hazards. Earthing design has also been advanced significantly during this time, meaning that we now better understand power system earthing and how to assess the hazard level present on metallic infrastructure within the vicinity of an HV installation.

Additionally, installation standards, including AS 2067 "Substations and high voltage installations exceeding 1 kV a.c." and New Zealand regulations have been improved to include additional requirements to increase the safety of High voltage installations. This includes clearance requirements between equipment, earthing assessment requirements, electrical protection requirements, and a number of other elements.

The above advancements are relevant to the water sector because pumping stations, sewage treatment plants and other installations frequently have high voltage infrastructure installed. Additionally, under normal circumstances HV infrastructure appears to be dormant. This means that until there is a failure, this infrastructure is often forgotten about and as a result, infrastructure that was installed in the 1980s and 1990s and is now approaching the end of its serviceable life often requires full scale replacement. In Australia, a number of water utilities have recently, or are presently undertaking large HV asset renewal programmes to bring their installations up to present standards. This presents an opportunity for New Zealand utilities to benefit from the learnings of the Australian utilities.

2 ARC FLASH HAZARDS

2.1 WHAT IS AN ARC FLASH?

An arc flash occurs when a current path is created through air between an electrical conductor and ground or another electrical conductor. This normally occurs because of equipment failure, human error or other inadvertent means (eg a tree branch falling across a power line). The hazard is then presented by the energy release through the arc. An arc flash produces a very large amount of energy which can result in severe injuries to personnel. Using the A. R. Van C. Warrington Formula, it can be calculated that a 13 kA fault on an 11 kV system lasting for 1 second releases an equivalent amount of energy to 1 kilogram of TNT.

2.2 ARC FLASH INCIDENTS

There have been two well publicized arc flash events in Australia and New Zealand in the last two years, resulting in 3 fatalities. The first occurred in Perth in February 2015, where two trained HV workers were killed as a result of the burns suffered. The second occurred more recently in June 2016 at the Ravensdown plant in Christchurch. Both of these incidents involved experienced personnel. While information is still emerging regarding the Christchurch incident, the Perth incident occurred when the personnel operated an oil filled fuse switch and the fuse switch exploded.

2.3 MANAGEMENT OF ARC FLASH HAZARDS

The first step in managing arc flash hazards is to identify the hazard level. In New Zealand the EEA published its “Management of Arc Flash Hazards” guide in 2011. This guide provides a policy statement that asset owners should complete arc flash assessments on all of their electrical infrastructure.

Once an arc flash assessment has been completed, mitigation can be implemented in the form of revised electrical protection arrangements, revised PPE requirements, restriction of access, and replacement of assets.

Older HV infrastructure has not traditionally been designed to contain the energy produced by an arc flash event. However, modern switchgear can now be purchased which has specific arc containment ratings, including the ability to vent the arc to a safe location.

In addition to replacement of switchgear with modern Arc Fault rated switchgear, some utilities in Australia have also elected to install remote switching panels for all of their HV installations, meaning that the operator does not have to be physically in the same room as the switchgear in order to operate it.

3 EARTHING

3.1 WHAT IS POWER SYSTEM EARTHING

Three phase AC power systems in Australia and New Zealand are generally designed with the neutral connected to earth. This means that if a phase or multiple phases make contact with earth (eg a powerline falling to the ground, the current return path will be through the earth. The current passing through the earth then creates a potential (voltage) rise at the substation which impacts surrounding infrastructure. In particular it can cause metallic infrastructure to have a voltage on it, which if touched can result in an electric shock, this is referred to as a touch potential hazard.

The modelling of earthing systems has been significantly advanced in recent years, meaning that we can now more accurately predict the hazard level.

3.2 STEP AND TOUCH POTENTIAL HAZARDS ON WATER INFRASTRUCTURE

Water infrastructure is prone to having step and touch potential hazards because of the pipes which are present in these systems, meaning that a pipe running near an HV installation can carry a potential voltage quite a far distance from the actual switchyard. This risk can be managed through a well designed earthing system.

4 MANAGEMENT OF HAZARDS PRESENTED BY HIGH VOLTAGE INFRASTRUCTURE IN THE WATER SECTOR

4.1 ARC FLASH HAZARD MANAGEMENT

A number of Australian water utilities (including Sydney Water and Melbourne Water) now specifically require that all HV switchgear be AFLR rated, meaning that the switchgear is able to contain an internal arcing fault in the front, rear and lateral directions. Additionally these utilities are now moving toward remote switching panels, so that their operators can operate the switchgear from a safe distance. Some utilities in Australia are beginning to mandate the use of fire retardant Personal Protective Equipment (PPE) for their HV installations. This is one area where New Zealand would be considered to be ahead of Australia, it is generally regarded as standard practice in the New Zealand HV industry to require fire retardant PPE.

4.2 STEP AND TOUCH POTENTIAL HAZARD MANAGEMENT

Although more awareness is being created around power system earthing and step and potential hazards, it is still an area which is not well understood in wider industry. Older installations are particularly vulnerable to this risk. When HV renewal projects are initiated it is essential that earthing is included as a component of it. Specifying a like for like replacement, may not be adequate, as the assessment of risks done for the initial installation would not have likely involved a detailed earthing investigation, as this has only recently (in the last ten to twenty years) become common practice.

There have been cases in Australia where existing installations have been assessed and significant touch potential hazards identified.

4.3 COMPLIANCE WITH AS 2067

In New Zealand it is not mandatory for HV installations to comply with AS 2067, however, this standard is a good base to work from. When HV assets are renewed it is recommended that they are designed to comply with the requirements of AS 2067 and relevant New Zealand regulations. One of the areas that has caused Australian utilities issues with this standard is the requirement for clearance from oil filled transformers. AS 2067 stipulates clearance between oil filled transformers and buildings, other transformers, or other flammable surfaces. As a result of this, we have seen that many existing installations when they are upgraded do not have adequate space to achieve the stipulated clearances. The main purpose for stipulating these clearances is to minimize the fire risk to adjacent infrastructure, and these requirements are also stipulated by FM Global in their loss prevention data sheets.

It is noted that AS 2067 is presently being revised and the revisions of this will further emphasize requirements for both earthing and arc flash assessments.

5 CONCLUSION

As aging HV infrastructure in the water sector approaches the end of its useful life it is prudent for asset owners to consider how they can safely and cost effectively replace this essential infrastructure. When planning to undertake this work it is important that water utilities understand that the standard of HV equipment and HV installations has increased significantly over the past several decades. As a result of this, simply specifying a “like for like” replacement is no longer adequate. The risks presented by HV installations and the mitigation of these risks are now better understood, so it is important that renewal projects account for these risks and adequately allow for their mitigation as part of the renewal process.

When renewing HV infrastructure, it is recommended that asset owners first undertake an assessment of their existing infrastructure. Undertaking a health and safety audit which includes an assessment of the existing installation against the requirements of AS 2067, and arc flash and earthing assessments, will allow the asset owner to fully understand the risks presented by their present infrastructure, and allow them to put a plan in place to mitigate these risks.

REFERENCES

FM Global, FM Global Property Loss Prevention Data Sheets 5-4, July 2012, Interim Revision April 2016

Standards Australia, AS 2067, Substations and high voltage installations exceeding 1 kV a.c., 2008