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Investigation into Possible Electrical Fire Outbreaks at Welders' Workshops at Siwdo Kokompe

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ABSTRACT
Building and shop wirings are the technology of distributing electricity for usages. Copper cables are relatively the best use cables for wiring than other conductors. Thus wiring must be done carefully by a qualified electrician to prevent possible electrical fire outbreaks. The welding profession which involves using large quantities of heat, gas and electricity was carefully examined by this research to find out if it could lead to possible electrical fire outbreaks. Conclusively, most of the wirings and fittings of these welders at Siwdo-Kokompe are in relatively good condition.
Key words: Wiring, Fire-out breakers, Welding, Cables, Safety.

INTRODUCTION

Generally, electrical wiring refers to insulating of conductors and their associated devices to transmit electricity from one place to another. Also wiring of buildings and shops refers to electrical wiring as methods or means of providing power in buildings and shops. The objective of this article is to investigate into possible electrical fire outbreaks at welders' workshops at Siwdo Kokompe. Wiring safety codes are intended to protect people (welders) from electrical shocks as well as fire outbreaks. Regulations must be properly established by national legislators so as to adopt standard codes produced by technical standard setting organizations. Internationally, there are conflicting standards as to the selection of wire sizes and design rules for electrical installations. The codes and rules must be modified periodically as recommended by stakeholders such as fire service personnel, engineers, power generators, electrical and electronic equipment manufactures among others. The process of permanently joining metals is known as welding and it is done by welders.

REVIEWED LITERATURE

Wiring History

The earliest interior power wirings are made of conductors that were bare or covered with cloth and secured by staples to frames or running boards of buildings and shops. The cloth tapes were to protect conductors which pass through walls. The wrappings of cloth tapes soaked in pitch were used to insulate underground conductors which were also laid in wooden trough and buried. These wiring systems were unsatisfactory due to the danger of electrocution, fire outbreaks and high labour cost. The knob and tube (K and T) method of wiring was later developed and used as an immediate advancement of welding. The K and T method involves single conductors passing through cavities between structural members in walls as well as channels containing joints. These conductors also pass through ceramic knobs attached to structural members to provide air between the wires, lumbers members and support. Also, there is one form of protection against short – circuit, thus by arranging wires on opposite sides with air freely circulating over them.

Impregnated – paper – insulated conductors have soldered joints and are not suitable for interior wirings because they need very specialized electricians for safety. A later development was the armored cables with two rubber-insulated conductors in a flexible metal sheath. Afterwards, cables consisting of two or more copper wires for insulation protection were used. These cables must be handled with care and replace in accordance to manufactures' specifications, since they become brittle when expose to atmospheric conditions. Two insulated conductors (wires) twisted together forms the simplest type of cables normally uses for low-voltage signal and control applications such as doorbell wiring. Relatively, higher voltages use the three twisted (triplexes) insulated copper wires of cables.

Aluminum cables.

Some years ago, aluminum cables were used as an alternative to copper cables for wiring of buildings and shops due to the then rising cost of copper, despite the fact that aluminum is a relatively poor conductor of electricity. In joining aluminum cables to copper cables, terminal blocks must be use. Aluminum conductors have relatively high resistivity, therefore it requires larger conductors sizes than copper. Often, when aluminum was use in wiring buildings or shops, the connections become defective unless all the devices such as breakers, switches, receptacles, splice connections among others must be of special alloy design for that purpose. Thus this design solves the problems between junctions of dissimilar metals, oxidation on metal surfaces as well as differential

expansion of metals at increasing temperatures. Aluminum gets cold-flow under pressure resulting to screw clamp connections getting loose, so spring-loaded connectors are used to produce constant high pressure cold joints in splices. Aluminum forms insulating oxide layer on it's surface and this problem may be solve by coating the surface with antioxidant paste which break through the oxide layer during installation.
In Ghana, aluminum cables are still use for bulk distribution of electricity due to the fact that they are relatively less expensive and weight less than copper. Recently in Ghana, aluminum cables are used to connect electricity from the poles to meters.

Copper cables
At Siwdo Kokompe cluster of artisans (welders) in Cape Coast, copper cables are use in the wiring of buildings and shops because of their high electrical conductivities, tensile strengths, ductility, creep resistances, corrosion resistances, thermal conductivities, coefficient of thermal expansions, solderabilities, resistances to electrical insulations and ease of insulation. Thus copper is used to conduct electricity in high, medium and low voltage power networks. Furthermore, copper cables are preferable used for power generation, telecommunications, data processing, industrial machinery, power transmission and distribution.

Wiring of shops of welders at Siwdo Kokompe
At Siwdo Kokompe, electricity distribution is the final stage of the energy delivery to the users or consumers, thus the artisans (welders, sprayers and mechanics). Thus the electricity distribution system or network carries electricity from the transmission system and delivers it to the welders. This network or system at Siwdo Kokompe consists of the following: specific voltage, power lines, substations, pole- mounted transformers, distribution cables and sometimes meters. At Siwdo Kokompe, electricity supply to (welders') artisans' buildings and shops are mostly of (1) single phase with very few cases of (3) three phase type. The (1) single phase type has (2) two of (16) sixteen mm cables connected from the poles to the single phase meter. Subsequently, (2) two of (10) ten mm cables are connected from the (1) single phase meter to the (1) single phase main switch. The (3) three phase connection has (4) four of (16) sixteen mm cables connected from the poles to the three phase meter. This phase has (4) four of (10) ten mm cables connected from the (3) three phase meter to the (3) three phase main switch.
Thus at Siwdo Kokompe, both the (1) single phase and (3) three phase wiring of buildings and shops have the same method given below. Both phases have the earthing consisting of a (10) ten mm or (16) sixteen mm cable connected from the earth pole underground to the main switch.

Lighting
A (1.5) one and half mm live cable, taking it's source from a (16) sixteen mm cable from the meter and a 10mm cable from the main switch is connected into the lighting switch. This (1.5) one and half mm live cable is extended to the lighting together with a (1.5) one and half mm earth cable which takes its source from the (10) ten mm or (16) sixteen mm earth cable in the main switch. Thus, lighting wiring consists of a (1.5) one and half mm live cable and a (1.5) one and half mm earth cable for both (1) single phase and (3) three phases.

Socket
Socket wiring for both (1) single phase and (3) three phases are the same. (2) two of (2.5) two and half mm cables for both neutral and live cables take their sources from (16) sixteen mm cables of the meter through (10) ten mm cables in the main switch. These (2) two cables are connected directly to the socket. The third cable is a (2.5) mm cable taking its source from the (10) ten mm or (16) sixteen mm earth cable of the main switch.

Welding theory.
Welding as done at Siwdo Kokompe in Cape Coast, is the process of permanently joining two or more metals by melting the points or areas. These molten parts of metals quickly cool and are permanently bonded. The practice of welding is an act of fabrication or sculptural process that joins metals. Thus welding involves melting the work piece and adding filter materials to form a pool of molten material that cools to become strong joint. The welding process at Siwdo takes place alongside pressure and heat. At Siwdo Kokompe, welding is the most economical and efficient way of joining metals permanently to make them a single piece .These welders have make welding vital to the Ghanaian economy which also ranks high among other industrial processes. Furthermore, welding involves more science as well as variables of measurement as compared to other industrial processes. Welding at Siwdo is differentiated from soldering and blazing by the fact that soldering and blazing involves melting of lower melting point materials (metals) to form bonds between the metals. Also at Siwdo, the energy sources use by these welders are gas flame and hydro-electricity. Other sources of energy that welders at different locations will use are laser, electron beam, friction and ultrasound. Welders at other locations may do

welding under water. Ignoring the precautions (safety) of welding by welders will result to hazardous conditions such as burns, electrical shocks, vision damage, inhalation of poisonous gases and exposure to intense ultraviolet radiations. Arc welding as done at Siwdo, makes use of power supply source (hydro-electricity) to create as well as maintain an electric arc between an electrode and the base metal to melt the metal at melting voltage. The amount of heat input is directly related to the current. Also, constant voltage or current supplies are important for automatic welding processes such as arc welding, flux core arc welding and submerged arc welding. These types of welding are length consistent due to the fact that any fluctuations in the distance between the electrode and the base metal are quickly rectified by a large change in current. Gas tungsten arc welding is a type of non-consumable electrode process for which the electrode rod only creates the arc but does not provide filler material. Stick welding involves using electric current to stick an arc between the base metal and the consumable electrode rod. This consumable electrode rod is made of filler material (steel) and is covered with a flux material that protects the weld area from oxidation and contamination by producing carbon dioxide (CO_2) gas during the welding process. Plasma arc welding uses plasma gas to make relatively more concentrated arc. Oxyacetylene or oxyfuel welding is the most common type of welding at Siwdo.

Oxyfuel or gas welding is the combustion of acetylene in oxygen to produce welding arc at flame temperature of about 3100^0 C which is less concentrated than an electric arc that causes slower weld cooling. Atomic hydrogen welding, electro gas welding, flux core arc welding, electroslag welding, electromagnetic welding, stud welding, resistance welding, ultrasonic welding, explosive welding and shielded metal arc welding are not found at Siwdo. Resistance welding results from heat generated by passing current through the heat resistor. Resistances welding is efficient, cause little pollution, limited in application but relatively expensive. Types of resistance welding are spot, seam, built, flash, projection and upset welding. Ultrasonic welding is a welding process which involves connecting thin sheets of metals by vibrating them at high frequency and pressure. The equipment and processes of ultrasonic welding is similar to that of resistance welding. Explosive welding involves the joining of dissimilar metals by pushing them together under extremely high pressure. Shielded metal arc welding is the process use in under water welding for construction, repair of ships, offshore platforms and pipelines.

Generally, $\left(\frac{V \times I \times 60}{S \times 1000}\right)$ x Efficiency = Q

Where Q – heat input

V = Voltage

I = Current

S = Welding speed.

Welding profession

Tradesmen who specialize in welding metals together are called welders and need to have good technical knowledge about the metals they weld. The profession of welding leads to the provision or manufacturing of equipment, automobiles, subways, bridges, pollution control devices, coffee pots, sky scrapers, oil drilling rigs, pipes, bulldozers, cranes, materials handling equipment, office machines, food processing machines, textiles and printing machinery. Welders at Siwdo Kokompe are also involved in maintenance and repairs. Also welders can seek employment in steel mills, smelting industries, refineries, aviation and petroleum industries.

Welding expenditure

The total cost involves in welding plays crucial roles to determine the quality and quantity of services provided by welders. Energy cost, material cost, labour cost, equipment cost and transportation cost are some of the many different variables that determine total cost of welded products. These variables influence the type of welding and products at particular times. Automated welding is more expensive than manual welding.

Welding safety

Welding is a very direct dangerous and unhealthy profession. Thus, if proper precautions (safety) and care are not taken by these welders, then they stand the risk of being expose to devastating industrial

health hazards as well as injuries. At Siwdo, welding is a hot work process involving open fire at excessively high temperatures. Thus, welders must wear protective personal equipment such as leather gloves, long sleeves jackets, goggles, helmets and safety shoes. They must surround all welding areas with translucent welding curtains made of polyvinyl chloride plastic to protect outsiders and bystanders from the ultraviolet lighting of the arc.

Fire Extinguishers

Generally, the extinguishers are designed to put off or control fires. The contents of fire extinguisher containers or bottles are known as extinguishing agents. These are water, chemical foam, dry chemical, carbon dioxide (co_2), aqueous film forming foam (AFFF) and halon. The common types of fire

extinguishers that must be use at Siwdo are water, multi-purpose dry chemical foam and compressed gas. The use of wrong fire extinguisher can be devastating.

METHODOLOGY

This methodology involves the mode of efficient data collection on electrical wires, electrical power availability, pressure on available electrical power, handling of sockets among others in densely populated industrial areas such as Siwdo Kokompe. This data collection was done at Siwdo Kokompe also due to the high possibility of fire outbreaks resulting from power over usage and multiple handling of wirings. Therefore, collection of quantitative and qualitative data was done for analysis to substantiate the conclusions and recommendation. This methodology also proves that there were problems to be solved in terms of wiring. Using this methodology, (21) twenty one questionnaires and interviews were administered to the welders.

TABLE 1

SHOP OWNER'S	SHOP NUMBER	SHOP OWNER'S PROFESSION	SHOP OWNER'S EDUCATIONAL LEVEL
MASTER EBO ARTUR	CCMA/SW/283	WELDER	J.H.S
MASTER MOSSES AMISSAH	CCMA/SW/120	WELDER	J.H.S
EKOW MENSAH	CCMA/SW/275	WELDER	S.H.S
MARTIN AKON	CCMA/SW/047	WELDER	ORDINARY LEVEL
MASTER J. AMOAH	CCMA/SW/302	WELDER	TECHNICAL
MASTER KUWAMI	CCMA/SW/ 205	WELDER	SIX FROM
MASTER KUMI	CCMA/SW/069	WELDER	J.H.S
BEN AMOKO	CCMA/SW/330	WELDER	J.H.S
MASTER OPPONG	CCMA/SW/215	WELDER	NIL
MASTER AMOASI	CCMA/SW/140	WELDER	J.H.S
FIFII NSAAKAH	CCMA/SW/079	WELDER	NIL
OSEI TWUM ASANTE	CCMA/SW/379	WELDER	J.H.S
MASTER ARUNA	CCMA/SW/407	WELDER	J.H.S
JOSEPH NKESTIA	CCMA/SW/199	WELDER	TECHNICIAN
SUMANI MUSTAPHA	CCMA/SW/206	WELDER	NIL
KWAME ADJEI	CCMA/SW/183	WELDER	NIL
FRANCIS ARUNA	CCMA/SW/175	WELDER	J.H.S
ELISAH COLEMAN	CCMA/SW/305	WELDER	NIL
MASTER AMOOS	CCMA/SW/210	WELDER	J.H.S
MASTER WIREDU	CCMA/SW/166	WELDER	J.H.S
MASTER DAZZIE	CCMA/SW/429	WELDER	TECHNICIAN

SOURCE: AUTHURS FIELD WORK 2013

TABLE 2

SHOP OWNER'S NAME	EVER TEMPERING WITH WIRES	ENGAGING QUALI FIED ELECRICIANS	CHANGE OF ELECRICAL FITTINGS	DO YOU HAVE FUSE	HAVE YOUR FUSE BLOW BEFORE
MASTER EBO ARTHUR	NO	YES	NO	YES	YES
MASTER MOSSES AMISSAH	NO	YES	NO	YES	YES
EKOW MENSAH	YES	YES	NO	YES	YES
MASTER AKOH	YES	YES	NO	YES	NO
MASTERJ. AMOAH	NO	YES	YES	YES	NO
MASTER KUMAMI	NO	YES	YES	YES	NO
MASTER KUMI	NO	YES	NO	YES	YES
BEN AMOAKO	NO	YES	YES	YES	YES
MASTER OPPONG	NO	YES	YES	YES	YES
MASTERAMOASI	NO	YES	NO	YES	NO
FIFII NSAAKA	NO	YES	YES	YES	NO
OSEI TWUM ASANTE	NO	YES	NO	YES	YES
MASTERARUNA	NO	YES	NO	YES	YES
JOSEPH NKESTIA	NO	YES	NO	YES	YES
SUMANI MUSTAPHA	NO	YES	NO	YES	YES
KWAME ADJEI	NO	YES	YES	YES	NO
FRANCIS ARUNA	YES	YES	YES	YES	YES
ELIJAH COLEMAN	NO	YES	YES	YES	NO
MASTER AMOOS	NO	YES	YES	YES	YES
MASTER WIREDU	NO	YES	YES	YES	NO
MASTER DADZIE	NO	YES	YES	YES	NO

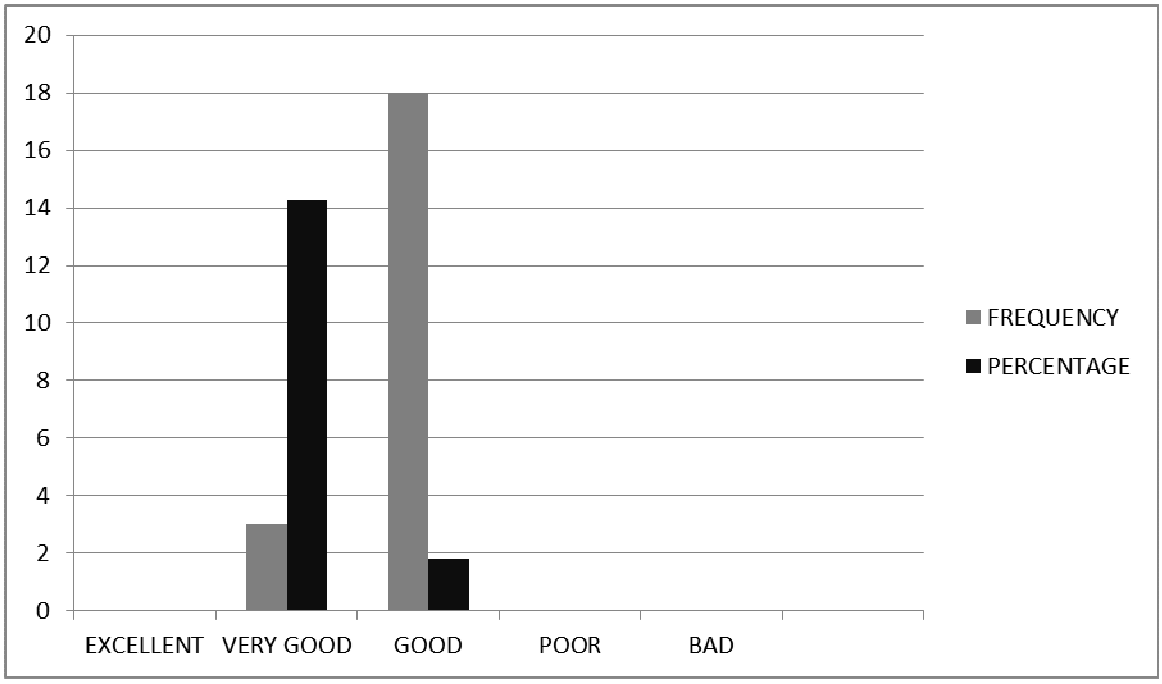
SOURCE: AUTHURS FIELD WORK 2013

TABLE 3

ISSUE	RESPONDS	FREQUENCY	PERCENTAGE
AVAILABILITY AND USAGE OF HAEVY DUTY EQUIPMENT	EXCELLENT	0	0
	VERY GOOD	||| = 3	$\frac{3}{21} \times 100 = 14.28$
	GOOD	𝍸 || = 18	$\frac{18}{21} \times 100 = 85.72$
	POOR	0	0
	BAD	0	0
TOTAL		**21**	**100**

SOURCE: AUTHURS FIELD WORK 2013

FIGURE 3



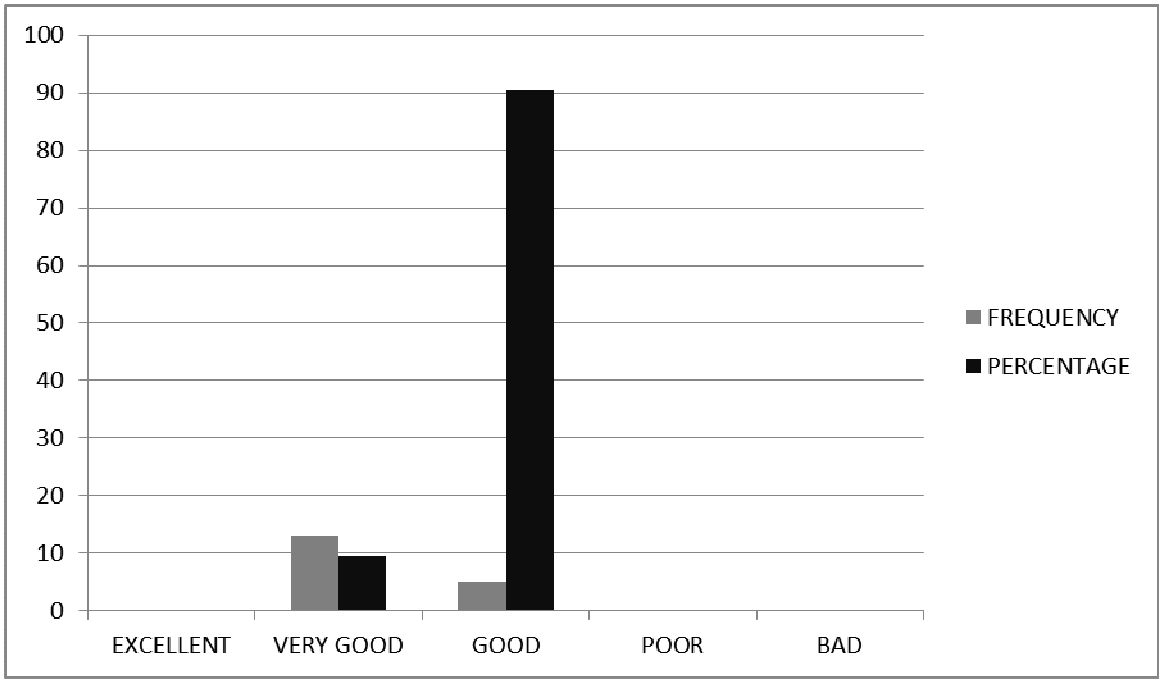
SOURCE: AUTHURS FIELD WORK 2013

TABLE 4

ISSUE	RESPONDS	FREQUENCY	PERCENTAGE
WORKERS SAFETY KNOWLEDGE ON ELECTRICAL FIRE OUTBREAK	EXCELLENT	0	0
	VERY GOOD	|| = 2	$\frac{2}{21} \times 100 = 9.52$
	GOOD	𝍸 ||| = 19	$\frac{19}{21} \times 100 = 90.48$
	POOR	0	0
	BAD	0	0
TOTAL		**21**	**100**

SOURCE: AUTHUR'S FIELD WORK 2013

FIGURE 4



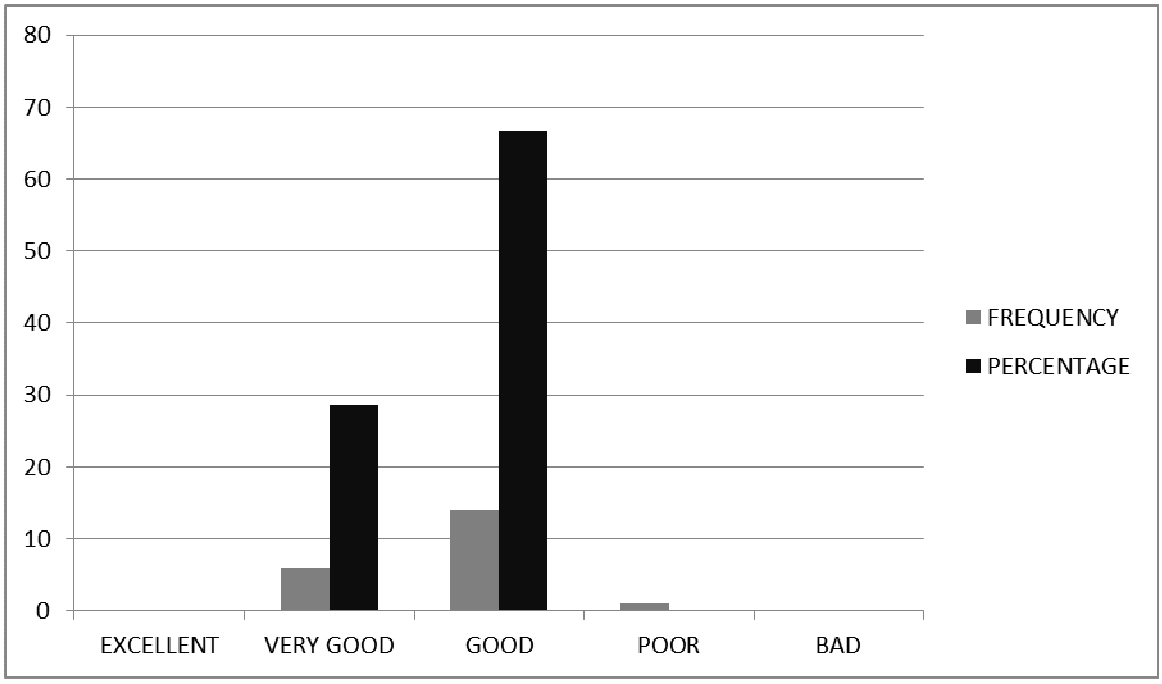
SOURCE: AUTHUR'S FIELD WORK 2013

TABLE 5

ISSUE	RESPONDS	FREQUENCY	PERCENTAGE
AVAILABILITY AND USAGE OF LIGHT DUTY EQUIPMENT	EXCELLENT	0	0
	VERY GOOD	𝍸 | = 6	$\frac{6}{21} \times 100 = 28.57$
	GOOD	𝍸 𝍸 ||| = 14	$\frac{14}{21} \times 100 = 66.67$
	POOR	| = 1	$\frac{1}{21} \times 100 = 4.76$
	BAD	0	0
TOTAL		**21**	**100**

SOURCE: AUTHUR'S FIELD WORK 2013

FIGURE 5



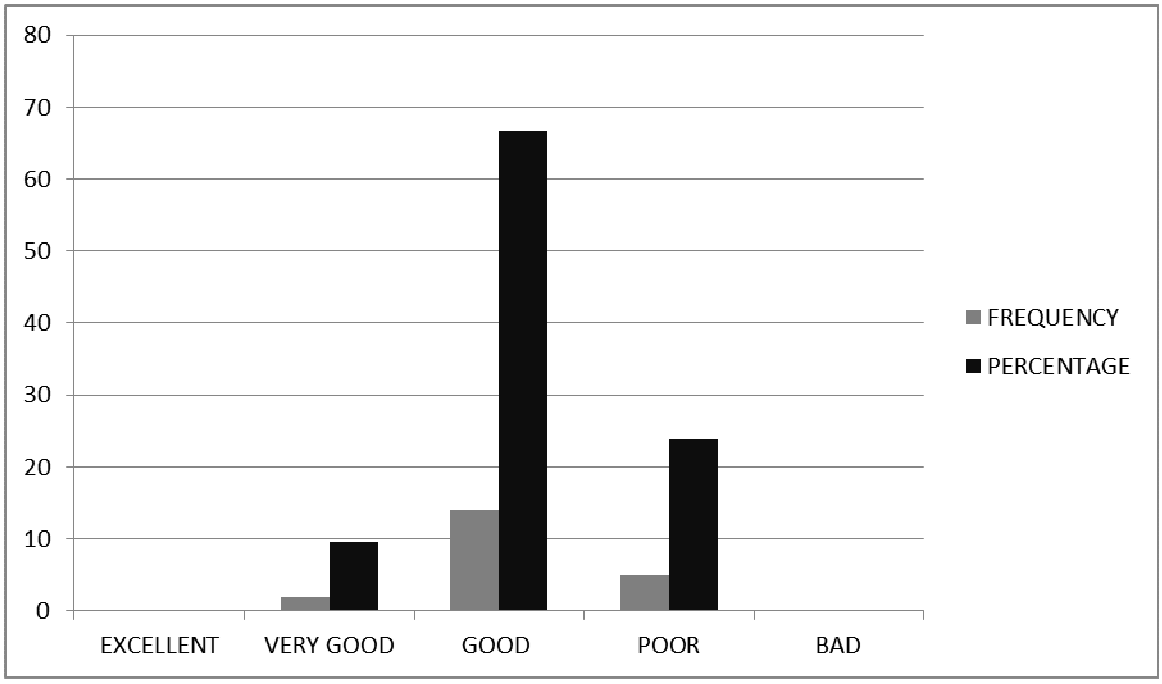
SOURCE: ARTHUR'S FIELD WORK 2013

TABLE 6

ISSUE	RESPONDS	FREQUENCY	PERCENTAGE
AVAILABILITY AND USAGE OF EARTHING SYSTEM	EXCELLENT	0	0
	VERY GOOD	|| = 2	$\frac{2}{21} \times 100 = 9.52$
	GOOD	𝍸 𝍸 ||| = 14	$\frac{14}{21} \times 100 = 66.67$
	POOR	𝍸 = 5	$\frac{5}{21} \times 100 = 23.81$
	BAD	0	0
TOTAL		**21**	**100**

SOURCE: AUTHUR'S FIELD WORK 2013

FIGURE 6



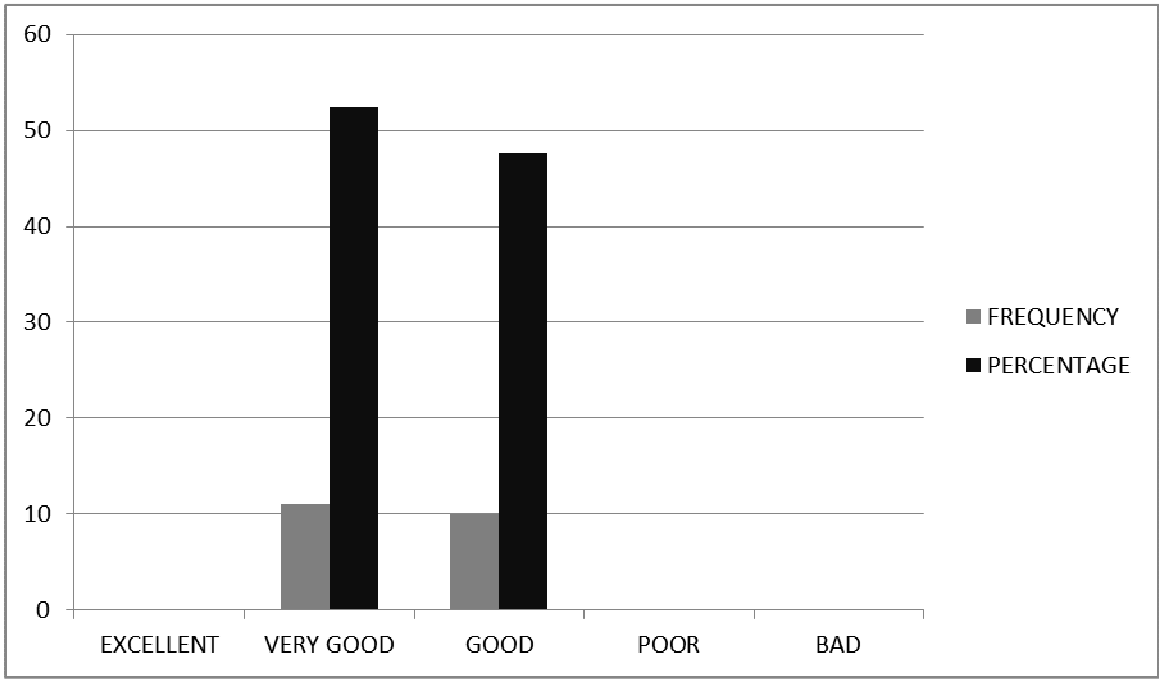
SOURCE: ARTHUR'S FIELD WORK 2013

TABLE 7

ISSUE	RESPONDS	FREQUENCY	PERCENTAGE
AVAILABILITY AND USAGE OF FUSE	EXCELLENT	0	0
	VERY GOOD	𝍸 𝍸 | = 11	$\frac{11}{21} \times 100 = 52.38$
	GOOD	𝍸 𝍸 = 10	$\frac{10}{21} \times 100 = 47.62$
	POOR	0	0
	BAD	0	0
TOTAL		**21**	**100**

SOURCE: AUTHUR'S FIELD WORK 2013

FIGURE 7



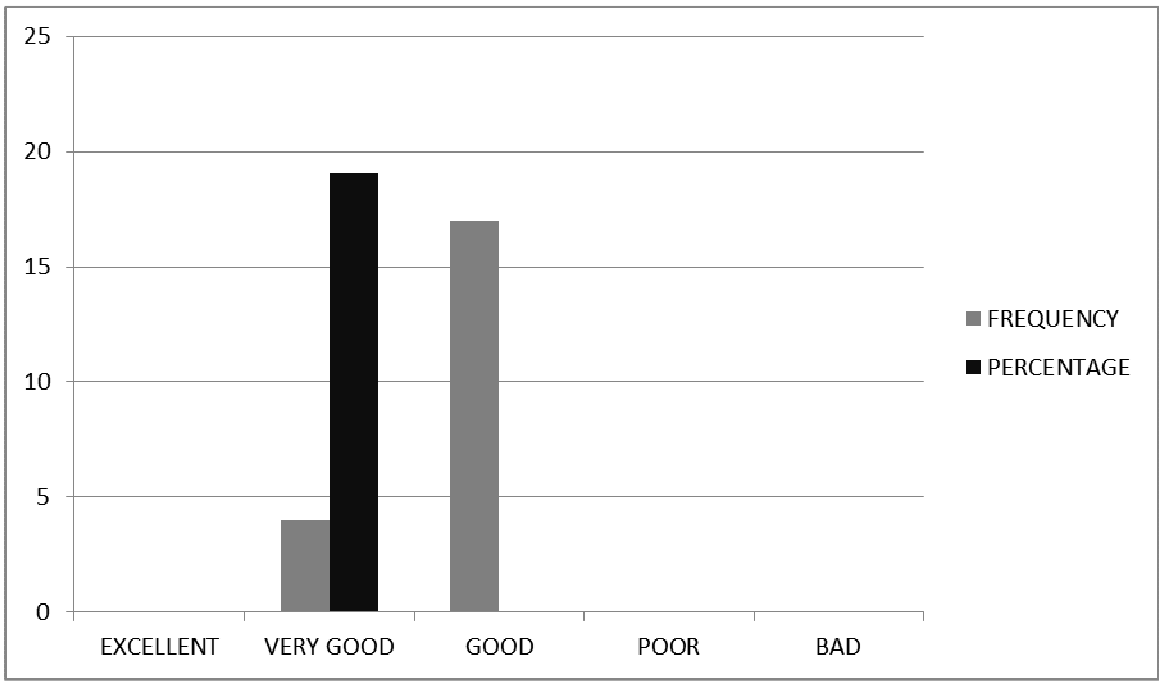
SOURCE: ARTHUR'S FIELD WORK 2013

TABLE 8

ISSUE	RESPONDS	FREQUENCY	PERCENTAGE
PERFORMANCE OF APPRENTICES AFTER THEY BECOME SHOP MASTERS	EXCELLENT	0	0
	VERY GOOD	𝍸 = 4	$\frac{4}{21} \times 100 = 19.05$
	GOOD	𝍸 𝍸 𝍸 || = 17	$\frac{17}{21} \times 100 = 80.95$
	POOR	0	0
	BAD	0	0
TOTAL		**21**	**100**

SOURCE: AUTHUR'S FIELD WORK 2013

FIGURE 8



SOURCE: ARTHUR'S FIELD WORK 2013

DISCUSSIONS

(5) five out of the (21) twenty one welders with reference to table 1 at Siwdo Kokompe have no formal education. (10) ten of these welders have basic education certificate at the Junior High School level. Also in table 1, there are (3) three welders who have technician education and (3) three welders with secondary education. All these welders in table 1 have been given shop numbers by the Cape Coast Metropolitan Assembly for easy identification.

In table 2, only (3) three of the welding shops at Siwdo-Kokompe in Cape Coast have tempered with their electrical wirings and fittings. All the welders engage qualified electricians in wiring their workshops. All of them have fuses incorporated into their electrical wirings. Also, in table 2, (12) twelve of these welders have their fuses blown before, whiles (9) nine of them do not have their fuses blown before. Availability and usage of heavy duty equipment as shown in table 3 have 14.29% very good, 85.71% good, 0% each for excellent, poor and bad. Table 4 shows that the welders or workers knowledge on safety for electrical fire outbreaks are 9.52% very good, 90.48% good, 0% each for excellent, poor and bad. Availability and usage of high equipment in table 5 shows 28.57% very good, 66.67% good, 4.76% poor, 0% each for excellent and bad. Table 6 indicates that usage and availability of the electrical earthing system have 9.52% very good, 66.67% good, 23.81% poor,0% each for excellent and bad. Fuse availability in the electrical wirings at the welders' shops at Siwdo Kokompe as indicated in table 7 have 52.38% very good, 47.62% good, 0% each for excellent, poor and bad. Table 8 shows that post apprenticeship performance of these welders have 10.05% very good, 30.95% good, 0% each for excellent, poor and bad.

CONCLUSION

Relatively, the educational levels of these welders are better than other groups of artisans at Siwdo Kokompe. In accordance with this research, the electrical wirings and fittings at these shops are good and averagely well maintain. Heavy duty equipment, light duty equipment, welders' knowledge in electrical fire outbreaks, fusing and earthing of electrical wirings are also in relatively good condition.

RECOMMENDATIONS

The author has made the following recommendations:

- There must be free trade restrictions as well as agreements on importation of electrical materials and gadgets into the country.

- Welders at Siwdo Kokompe must abide with the information on the "Electricity Company of Ghana Service Connection for Supply".
- All documents of the Electricity Company of Ghana must be made available in all Ghanaian languages for efficient customer services.

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