Managing Industrial Raw Materials and Its Operational Hazard/Risk Evaluation for Maximum Utilization: A Case of Selected OCTG Companies in Nigeria.

Owobu Joshua Mark

Abstract— Generally, industrial operational activities are associated with several inherent risk, which comes in different forms depending on the type of industrial activity going on. This article focused on Managing Industrial Raw Materials and Its Operational Hazard/Risk Evaluation for Maximum Utilization, using two OCTG Companies (oil country tubular goods) in Nigeria as a case study, whose major operations is on OCTG Pipe threading. In this article, we will be considering examples of raw materials used in the pipe-threading operational process of an OCTG Company (oil country tubular goods), management of the different raw materials, associated risk, its evaluation and mitigation. The aim of this article is to proffer a better way of handling and managing of raw materials for maximum utilization and to protect the health and safety of but the material handlers, the end users and protection against its negative impact on the environment. The paper concludes that, should practitioners become proactive by applying proffered solutions, efficiency will be achieved in management of operational raw materials and the safety of material handlers and the end users will be assured and the negative impact on the environment resulting from poor management, will be greatly minimized.

Index Terms— Control measures, Hazard, Hazard identification, Material Safety Data Sheet, OCTG, Raw material, Risk assessment, Storage, Warehouse.

1. INTRODUCTION

The industrial age comes with lots of innovations and challenges. One of the major challenge lies in the area of risk associated with the various operational activities, among which the proper management of raw materials used in the operations is key. Improper handling and management of raw materials has lots of negative impact on both the finished product, the handlers, the end users and the environment at large. This negative impart or disadvantage will briefly be outline later in this article.

Raw materials are the input goods or inventory that a company needs to manufacture its products. Raw materials are the basic materials from which products are manufactured or made (Oxford English Dictionary). Raw materials can be direct raw materials, which are materials that are directly used in the manufacturing process; indirect raw materials are not part of the final product but used comprehensively in the production process.

According to Barnett & Clark, 1996, Firms in the process industries utilize production processes that manipulate material properties to produce upgraded raw materials for subsequent use in a variety of application areas upstream in a supply chain.

Raw materials comes in various forms and are composed of several biological and non-biological substances, some of which are very hazardous to human health and the environment. Hence, there is need for users to be aware of the associated risk, be able to evaluate these risks and to proffer solution on how to mitigate it for the betterment of humans and protection of environment.

Every industry is to have an integrated risk management system to manage risks associated to their industrial activities. An integrated risk management system refers to a set of practices designed to help organizations understand and manage the full scope of risks facing their company.

Oil Country Tubular Goods (OCTG) are widely used across the global oil and gas industry. The Pipe threading aspect of the OCTG Company (oil country tubular goods) is an interesting arm in the oil and gas industry since most of

Owobu Joshua Mark holds a Ph.D. Degree in Business Administration - Operations & supply Chain Management from Charisma University, Nigeria, PH: +2348032392423. E-mail: joemark_77@yahoo.com

its threaded pipes are used in the oil field and at such all activity must be carried out with precision, safety and quality. Pipe threading undergoes various rigorous process that involve the use of different industrial raw materials at each stage of the threading operation before achieving the finished product (threaded Pipe). It is of high importance that all materials are safely handled, stored and delivered, in accordance to manufacturer and client specifications. Failure resulting from any of the processes can be catastrophic to the end-point of use that is the oil field.

1.1 Statement of the problem

The researcher in his years of working in the oil and gas industries has observed that there are cases of product failures in key oil field facilities resulting in catastrophe due to poor management of industrial raw materials used in their operations. These problems cause property damage, loos of resources, loss of life, environmental degradation, company loos of reputation, loos of clients and market share for the company. This situation have persisted even as the firms involve in more complex project. This study therefore sought to proofer a solution to mitigating these challenges through proper management of raw materials used in the various operations and evaluating the risk.

1.2 Research Question

The study aimed to provide answers to the following questions;

1. To what extent does poor raw material management affects the quality of finished product in an OCTG pipe threading operation.
2. What are the safety implications in raw material management (handling, storage and usage)?
3. How can the operational risk in raw material management be mitigated

1.3 Research Objectives

The aim of the study is to proffer a better way of handling and managing of raw materials for maximum utilization and to protect the health and safety of but the material handlers, the end users and protection against its negative impact on the environment.

The specific objectives of the study are:

1. To find out the relation between raw materials and the finished product quality
2. To determine the effect of poor raw material management on the finished product
3. To ascertain if there are risk associated with raw material management (handling, storage and usage) and to proofer a safer way of managing them.
4. To mitigate the impact of raw material on the environment

2. LITERATURE REVIEW

2.1 Concept of industrial raw material

Raw material is define as the crudest form of product possible, which is used as an input for making another product. Raw material is essentially the unprocessed product and is the chief constituent of the primary product that is processed or manufactured. Raw materials are also an important part of a firm's inventory management. They are component parts of the stock of inventories carried by a manufacturing firm at a given time. Every organization has inventories of some type and the economics and techniques of inventory management are critical for efficient operation, profitability and survival, especially in a highly competitive environment.

2.2 Importance of Raw Materials

There are mainly four factors of production. Raw material falls in the category along with labor and capital. This crucial element makes these goods an indispensable commodity for a manufacturing enterprise and a country.

Effective and efficient maintenance of raw material is one of the most crucial task for any inventory management system. Raw material in inventory management is the material needed by the warehouse to produce the furnished goods. Raw material in inventory can be primary components, the assemblies or the sub-assemblies required to produce a furnished good. Raw material, are the indispensable component of the production cycle. Quality of raw materials determine the quality of the final output.

2.3 Types of raw materials

Raw materials are basically classified as:

1. Direct raw material: These are basic unprocessed materials or resources. Goods like metals, wood, sand etc. are direct raw materials i.e. they are in their natural form or becomes part of the finished product.
2. Indirect raw material: Materials, which are not required to make the finished product, but without which production of final goods cannot be actualize. Goods like personal protective equipment such as helmet, gloves, tools, etc.

2.4 Raw material management

Bailey & Farmer (2009), defined material management as a concept concerned with the management of materials until the materials have been used and converted into the final product. According to Ramakrishna (2005) and Gopalakrishnan & Sundaresan (2006), material management is a function of coordination of planning, sourcing, purchasing, moving, storing and controlling materials in an optimum manner to provide a predetermined service to the customer at a minimum cost.

Raw materials management is the activities that go into areas such as acquiring, purchasing, refining, developing and

delivering a sufficient amount of raw materials at a sufficient quality to ensure that the strategic and operational objectives of the firm is achieved. Raw materials management thus implies exchanges with the external environment, as well as firm-internal material conversion issues. Effective raw materials management means performing all these activities proficiently, i.e. faster, with higher quality, lower risk, and with fewer inputs and defects.

Song, Haas and Caldas (2006); Cross (2019); Kisioya and Moronge (2019); Oteki and Sakwa (2020) are of the view that companies engaging in efficient material management are most probable to perform better than those that do not and realize significant savings in total costs of production; hence, effective materials management can result to cost reduction, savings and overall, productivity.

Barker (1989); Linton, Klassen and Jayaraman (2007) acknowledged five main functional areas of materials management to include purchasing, inventory and quality controls, warehousing/storage, distribution and production (raw materials conversion to work-in-progress and finished goods).

Banjoko (2009) emphasizes that for organizations to enhance productivity, it must consider materials management as the lifeblood of the production process. This means that organizations materials for production must be available at a suitable price, quantity, quality and be able to coordinate and schedule production activity.

2.5 Material safety data sheet (MSDS)

WHMIS (1988) (Workplace Hazardous Materials Information System) defines a Material Safety Data Sheet (MSDS) as a document that contains information on the potential hazards (health, fire, reactivity and environmental) and how to work safely with the chemical product. It is an essential starting point for the development of a complete health and safety program. It also contains information on the use, storage, handling and emergency procedures all related to the hazards of the material. The MSDS contains much more information about the material than the label. The supplier or manufacturer of the material prepares MSDS. It is intended to tell what the hazards of the product are, how to use the product safely, what to expect if the recommendations are not followed, what to do if accidents occur, how to recognize symptoms of overexposure, and what to do if such incidents occur.

Every industrial material is required to have an accompanying MSDS that is specific to each individual product or material (both the product name and supplier on the MSDS must match the material in use).

A standard MSDS should contain at least nine (9) categories of information. These categories include:

1. Product Information: product identifier (name), manufacturer and suppliers names, addresses, and emergency phone numbers
2. Hazardous Ingredients
3. Physical Data
4. Fire or Explosion Hazard Data
5. Reactivity Data: information on the chemical instability of a product and the substances it may react with
6. Toxicological Properties: health effects
7. Preventive Measures
8. First Aid Measures
9. Preparation Information: who is responsible for preparation and date of preparation of MSDS

Under WHMIS law, an MSDS for a controlled product must not be more than three years old. The three-year time limit does not apply to MSDSs for non-controlled products (i.e. products that do not meet WHMIS criteria). If new, significant information becomes available before the three years has elapsed, the supplier is required to update the product label and MSDS. If there is no new information on the ingredients by the end of the three-year period, the supplier should review the MSDS and the label for accuracy, revise it where necessary, and revise the preparation date on the MSDS.

2.6 The Concept of Risk Management & Evaluation

According to the International Health and Safety at Work by Hughes & Ferrett, (2013), a risk is the likelihood of a substance, activity or process to cause harm and its severity. Hughes & Ferrett, (2013), further stated that, a risk can be reduced and the hazard can be eliminated or controlled by good management. The presence of hazards in any work environment is a potential source of danger with the likelihood of causing harm to workers. Thus, for any industry to achieve success, it must first conduct hazard and risk assessment to identify hazards that pose risk to workers in the work environment.

Some of the common approaches to minimize the risk are through hazard identification, risk assessment, and risks control based on the Occupational Safety and Health (OSH) rules and regulations (Anthony & Noya, 2015, and Journal, 2017).

Hazard identification means the identification of undesired events that lead to the materialization of the hazard and the mechanism by which those undesired events could occur (Director General Department of Occupational Safety and Health, Malaysia, 2017).

Risk assessment is a systematic process for describing and quantifying the risks associated with hazardous substances, processes, actions, or events (Covello and Merkhoher, 1993).

Hazard or Risk control means the process of implementing measures to reduce the risk associated with a hazard (Director General Department of Occupational Safety and Health, Malaysia, 2017).

Risk management is the process of identifying, assessing and controlling threats to an organization's capital and earnings. These risks stem from a variety of sources including financial uncertainties, legal liabilities, technology issues, strategic management errors, accidents and natural disasters.

In the risk-management standard AS/NZS 4360, risk is defined, as the chance of something happening that will have the negative impact on the target, measured by the law of cause and effect. Risk is measured based on likelihood and consequence.

2.7 Raw material risk management

Protecting of raw materials is a vital part of production process that required serious attention. Repercussions like plant shutdowns and rejected product due to poor quality of raw materials etc. can be far-reaching and difficult to overcome. To help safeguard product and avoid potential adverse events, the following precautions are recommended when sourcing media.

1. Raw Materials Handling

The following raw material control principles are important to ensure consistency and quality:

- **Sourcing of the Highest Grade Materials**: High compendia-grade components assure purity and consistency of final product.
- **Incoming Raw Material Testing and Inspection**: Each raw material is different; therefore, relevant incoming Quality Control testing is necessary. Every shipment of every raw material lot required testing upon receipt, utilizing an acceptable statistical sampling plan. At very minimum, raw materials require testing for identification, endotoxin, and moisture. Depending on the type and use, the raw material can as in addition require bioburden testing, enteric organisms, virus, and mycoplasma, at a minimum.
- **Continuous Supply Chain Management:** This strategy provides the ability to manage the supply chain towards transparency. Through this, you can foresee current and potential challenges with raw material supply to reduce future issues. Ongoing and proactive quality monitoring of suppliers provides better control and advances preparation for changes on the raw materials. Suppliers must be qualified, utilizing a risk-based approach with continuous improvement requirements via scorecards reports.
- **Dual Sourcing of Raw Material**: Dual sourcing is a way to ensure supply continuity as a preventive measure to avoid production delays, and it improves inventory management.
- **Customer-Specific Raw Material Requirements**: Organizations have specific requirements for the handling of their critical raw materials. It is important that an organization utilize a system that supports handling of custom raw materials such as sourcing and/or specifications.

2. Evaluating risk and adequacy of current control

Risk evaluation is the determination of risk management priorities through establishment of qualitative and/or quantitative relationships between benefits and associated risks." The purpose of risk assessment is to reduce residual risk to as low as reasonably practicable (Hughes & Ferrett, (2013), Evaluating a risk means making a decision about its severity and ways to manage it. Evaluating risk is a system of ranking risk, the higher the risk level the sooner it must be address and controlled.

In Qualitative Risk Analysis, qualitative analysis such as rating probability and impact should always be performed. This allows you to quickly prioritize and rank your risks. Quantitative risk analysis is a numeric estimate of the overall effect of risk on the project objectives such as cost and schedule objectives. The results provide insight into the likelihood of project success and is used to develop contingency reserves.

This work is limited to being able to evaluate the operational risk in handling and managing industrial raw materials for maximum utilization in threading of OCTG pipes/tubes, for this reason we will be majoring on the qualitative risk analysis in evaluating the risk related to handling and managing the industrial raw material required in the threading operations.

2.8 OCTG Pipe Threading & Inspection Services

OCTG Pipe threading and inspection involve various process and all of these processes require the use of one or more raw material(s) that must be properly manage to get a quality finished product delivered to the client.

1. Swaging and sizing
2. Pipe threading
3. Phosphating
4. Buck-on
5. Pipe Finishing/Maintenance

3. METHODOLOGY

Because of the explorative nature of this research, qualitative methods were most suitable. The main reason for this is that qualitative analysis is particularly suitable for investigations

where multiple possible answers are relevant. Patton (2015) stated that using the qualitative methodology enables a researcher to obtain information regarding the research problem through an inductive process that involves the use of interviews. According to Marshall and Rossman (2014), qualitative research is realistic, interpretive, and grounded in people's experiences. For an elaboration of the pros and cons of qualitative data approaches, see Yin (1989), Miles and Huberman (1984), Eisenhardt (1989).

3.1 Research Design

Two (2) OCTG Pipe threading and inspection companies were used in this study, The Top Management staffs and key operations personnel were interviewed on the topic of study by asking some questions which helps in achieving the aim of the study. Respondents representing different organizational functions within the firm, such as finance, supply chain management, production, Warehousing, purchasing, and yard (logistics). The aim of these interviews was to get a comprehensive and at the same time deep understanding of how raw materials are handled within the firm. The results and findings from the interviews were thereafter analysed.

The interview questions where framed around specific themes such as:

- The effects of raw materials on the operations of the firm, and how the firm handle challenges stemming from raw materials,
- How raw materials affect different parts of the organization,
- The long term aspects of raw materials management and
- Knowledge of the associate risk involve in handling the various raw materials used in their operations.

Adding to the structured data, was unstructured data represented by data collected from inspecting the workplace, reviewing department procedure manual, work instructions, standard operating procedure, previous incident reports, material safety data sheet, first aid/injury register, and health record of employees.

3.2 Sample Size and Sampling Technique

This study used a sample of forty (40) respondents drawn from two (2) OCTG Pipe threading and inspection companies located in Onne, Revers State, Nigeria. Twenty (20) respondents from each of the company, to find out how industrial raw materials used in their operational processes are currently managed and how they are able to manage the associate risk for maximum product utilization.

The respondents from the two (2) companies that were used in this study, were interviewed on the topic of study by asking some structured questions which helps in achieving the aim of the study. The questions where structured to encourage respondents to provide detailed responses of their experiences and insights into raw material management and risk mitigation.

3.3 Method of Data Collection

The following methods of data collection was use in the study:

a. Questionnaire
b. Personal Interviews.

The research questionnaire was a structured one and was administered to forty (40) respondents that comprises of top Management staffs and key operations personnel from the two (2) OCTG Pipe threading and inspection companies that were surveyed. Twenty (20) respondent where drawn from each company. It was intended to extend the respondents to both top management staff and key operations personnel in order to get insight to both the theoretical and practical practice of the organizations since the top management knows more of the theories while the operations personnel knows more of what is actually practice in their organization.

Furthermore, to be able to get a practical result on the safety aspect of evaluating the hazard/risk, the study applied HIRARC (Hazard Identification, Risk Assessment, Risk Control) method, consisting of a series of Occupational Safety and Health (OSH) practices including identification of hazards, estimating of risks, and determining of control measures (Ahmad, et al.) The essence of Risk assessment is to identify potential hazards while controlling risk in process, operations or activities at an acceptable level. Through the risk assessment, the likelihood of occurrence (L), and hazard severity (S) or consequence (C) were assessed. The likelihood of occurrence shows how possible the accident occurred, while the severity or consequence shows how severe the impact of the accident. According to (Ahmad, et al.), the values of likelihood and severity will be used to determine risk rating or risk level.

Risk is measured based on likelihood and consequence. The stages of the HIRARC in the context of warehouse are identifying the workgroup in the warehouse, identifying hazards and risks that may occur, recording the frequency of hazards and risks, determining the likelihood level, determining the consequences' level, calculating the risk score, and determining the risk level.

4. DISCUSSION OF FINDINGS

This chapter will present the findings from the two companies that were survey in the course of the research,

findings from the interview and observations will be presented to show the current state in the companies. The chapter begins by interpreting the primary literature, followed by the current state in the surveyed companies and finally the researcher's viewpoint.

4.1 Discussion

The essential questions asked during the interview to provide detailed responses of their experiences and insights into raw material management and risk mitigation where, as follows:

Raw Materials

1. Do you have a standard procedure for the qualification of your suppliers?

   If Yes, please specify the method used:
   Audit
   Questionnaire
   Other (Please specify): _____

2. Do you have storage warehouse for the different categories of operational raw materials?

   If yes, please specify the different warehouse you have and the category of raw materials stored in them

3. Is your warehouse equipped with modern warehouse storage and handling facility for safe and easy operations?

4. Are the entire Warehouse personnel, trained for the job?

   If yes, please list some of the training you have don

5. Are you aware of the potential hazard in the materials you are handling and the risk associated to the operations?

   If yes, please give a list of some of the raw materials used in your operations and their risk/hazard and safety precautions that is require in safeguarding you.

6. Do you evaluate the risk associated with your job?

   If yes, please show the format you use in evaluating risk/hazard

Product Recall & Complaints

7. Do you have a standard procedure for the recall of products?

8. Do you have a standard procedure for processing complaints?

Internal Audit Program

9. Is there an internal audit program for the various departments?

10. Is a written report produced after each audit?

    If Yes, is the report written using a specific report format produced by the quality assurance department?

11. Does the internal audit program cover at least the following?
    - hygiene,
    - traceability,
    - HACCP,
    - batch recall and withdrawal test

12. Are internal audits conducted regularly by authorized persons from within the company or by third-party auditors that are sufficiently well qualified to assess compliance with quality requirements?

Quality Control

13. For each batch of raw materials procured, were each delivered with a full certificate of analysis in advance or accompanying the product/raw material?

14. Do you have a leading official responsible (qualified person) for approval of materials and for the release of products?

    If yes, please specify qualification and position within your company:

15. Do you have a standard procedure for validation of materials used in the operations?

16. Do you have a record of controlling Expired raw materials?

17. Do you have a batch record for every batch, undersigned and dated, reporting rate of production, registration of production steps, registration of control and release by the qualified person?

    If Yes, are batch records kept under controlled access?
    If Yes, how long do you retain batch records?

18. Do you have an internal quality laboratory?

    If Yes, please list and specify some analyses that are done internally

19. Do you sub-contract your analytical control to an independent Quality Lab?

    If Yes, please specify the name/s and add the certification of the lab/s?

20. Have you recorded any case of threaded pipe rejection resulting from defeat in raw material used?

    If Yes, in which operational process of the job?
    If Yes, please give details of one of such rejection.

4.2 Findings

This section will give brief explanation of the current happenings in the companies that were surveyed by giving answers to the questions asked during the interview with respondents from the two companies.

Raw Materials

1. All forty- (40) respondent from both companies affirms that their company has a standard procedure for the qualification of their suppliers.

   Furthermore, respondents of "Company A" stated that their company uses site audit as a procedure for the qualification of their material suppliers, this they were able to prove my showing me a documented report of one of their audit visit to a local supplier that suppliers METAL GUARD 950 (VARNISH) used for finishing process in their operation.

   In addition, respondents of "Company B" stated that for local suppliers of raw materials, site audit is carried out as a procedure of qualifying their vendors but for foreign suppliers, a Questionnaire with details of key factors of such material is send across to the supplying company which must be properly answered and send back with pictorial evidence and lab test result where necessary as a prove of their claims.

2. Respondents from "Company A" stated that they do have storage warehouses for the different categories of operational raw materials and that they are categorized base on the storage requirement recommended by the manufacturer as found in each material safety data sheet (MSDS). Example are the Temperature regulated material warehouse, corrosive material warehouse and Explosive or Highly Flammable material warehouse etc.

   Respondents from "Company B" stated that they only have two storage warehouse for raw materials and the two warehouse are categorized as Chemical Warehouse and General raw material warehouse. The Chemical warehouse is used for storage of chemicals and Lubricant while the General warehouse is used for storage of non-chemical composed raw materials.

3. Respondents from both companies surveyed stated that their warehouse is equipped with modern warehouse Storage and handling facility for safe and easy operations. Some warehouse storage and handling facilities sited and listed by the respondents are listed in Table 1 below.

Table 1: List of modern warehouse Storage and handling facility (source: Surveyed companies)

Storage Equipment	Lifting Equipment	Conveyors	Dock Equipment	Packing Equipment
1. Bins and Totes	1. Forklifts	1. Gravity Roller Conveyor	1. Dock Boards and Plates	1. Industrial Scales
2. Shelves	2. Pallet Jacks	2. Belt Conveyor	2. Edge of Dock Levelers	2. Strapping and Banding Equipment
3. Racks	3. Hand Trucks	3. Plastic Belt Conveyors	3. Truck Restraints	3. Stretch Wrap Machines
4. Carousels	4. Service Carts	4. Flexible Conveyors	4. Dock Seals and Shelters	4. Packing Tables
	5. Cranes, Hoists, and Monorails	5. Vertical Conveyors	5. Dock Bumpers	
		6. Spiral Conveyors	6. Yard Ramps	
		7. Pneumatic Conveyors	7. Wheel Chocks	
		8. Chain Conveyor	8. Dock levelers & Dock Lifts	
		9. Dust Proof Conveyors		
		10. Automotive Conveyors		

4. All respondents from both companies affirms that their entire Warehouse personnel are well trained for the job before they resume their job position. They further stated that, periodically, refresher trainings are organized for the warehouse personnel.

   Some of the training they have done includes chemical handling and management, 5S Training, Storage and handling equipment Training, Warehouse management System, warehouse processes, Warehouse Safety Training, etc.

5. Respondents from both companies are aware of the potential hazard in the materials they are handling and the risk associated to the operations.

   A summary of the list of some of the raw materials used in their operations and their risk/hazard and safety precautions that are require in safeguarding the personnel can be found in Table 2 below

Table 2: list of some of the raw materials used in their operations and their risk/hazard (source: Surveyed companies)

S/NO	OCTG Pipe Threading & Inspection Services	MATERIAL DESCRIPTION	HAZARD STATEMENT (ASSOCIATED HAZARD/RISK IN MATERIAL)	HANDLING	STORAGE	DISPOSAL
1	**Swaging and sizing**	**RENOFORM SYO L**: Metalworking fluid	Flammable liquid and vapor. Causes eye irritation. May be fatal if swallowed and enters airways	End-users should follow industry best practices for handling and using this product.Guidance may be found using the current version of ASTM Standard E1497-05: Standard Practice for Selection and Safe Use of Water-Miscible and Straight Oil Metal Removal Fluids. Observe good industrial hygiene practices. Wear appropriate personal protective equipment. Do not expose to intense heat as product may expand and pressurize container. Avoid contact with eyes. Wash hands thoroughly after handling. Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking. Ground and bond container and receiving equipment. Take precautionary measures against static discharges.	Store locked up. Store in a well-ventilated place. Store in a cool place. Flammable liquid storage	Dispose of contents/container to an appropriate treatment and disposal facility in accordance with applicable laws and regulations, and product characteristics at time of disposal.
2	**Pipe threading**	**KENDEX OCTG**: Pipe Dope, Grease	May cause eye irritation, May cause skin irritation. (This material is NOT considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200))	Eating, drinking, and smoking should be prohibited in areas where this material is handled, store and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. Do not get in eyes or on skin or clothing. Do not ingest. Avoid breathing vapor or mist. Use only with adequate ventilation. Use non-sparking tools.	Maximum storage temperature is 93°C. Store in accordance with local regulations. Store in segregated and approved area. Keep in the original container tightly closed. Store locked up in a dry, cool and well-ventilated area, away from incompatible materials. Do not store in unlabled container. Store and use away from heat, sparks, open flame or any other ignition source. Take precautionary measures against electrostatic discharges. To avoid fire or explosion, dissipate static electricity during transfer by grounding and bonding containers and equipment before transferring material. Empty containers that retain product residue may be hazardous. Do not reuse container.	Not a hazardous waste if disposed of as is, by the definitions of the U.S. EPA. Dispose of properly complying with appropriate laws and regulations.
		AQUASOL METAL FLUID: Water based degreaser	Material can create slippery conditions. Contact with metals may evolve flammable hydrogen gas. Causes respiratory tract irritation. (Mist). Inhalation may cause central nervous system effects. May cause central nervous system depression. Symptoms and signs include headache, dizziness, fatigue, muscular weakness, drowsiness and in extreme cases, loss of consciousness.	Avoid contact with skin, eyes and clothing. Avoid breathing vapors or mists.	Store in original container. Keep containers tightly closed in a dry, cool and well-ventilated place. Freezing will affect the physical condition but will not damage the material. Thaw and mix before using.Storage Temperature Minimum 35 °F / 2 °C Maximum 120 °F / 49 °C	Dispose off in accordance with local regulations. Empty containers should be taken for local recycling, recovery, or waste disposal
3	**Phosphating**	**GARDOBOND-ADDITIVE H 7204**: Additive for surface treatment of metals.	Causes skin irritation. Causes serious eye irritation.	Do not return residues to the storage containers. Provide good ventilation of working area (local exhaust ventilation if necessary). Avoid inhalation of vapour and spray mist. The workplace should be equipped with an emergency shower and eye-rinsing facility. Avoid contact with skin and eyes. Keep away from food, drink and animal feeding stuffs. Warn users about safety measures and precautions to prevent accidents. Protection against fire and explosion: The relevant fire protection measures should be noted	Suitable materials for containers: Polypropylene (PP), Polyethyleneterephtalate (PET), Low density polyethylene (LDPE), High density polyethylene (HDPE). Further information on storage conditions: The entrance to storage rooms is to be granted only to appropriately trained personnel. Keep only in the original container. Keep container tightly closed in a cool, well-ventilated place. Avoid direct sunlight. Avoid contact with amphoteric metals (e.g. aluminium, lead, zinc). Protect from frost. Storage temperature: 0 - 70 °C	Observe national and local legal requirements. Contaminated packaging should be emptied as far as possible and disposed of in the same manner as the substance/product.
		GARDOBOND Z 3400E1: Phosphating solution for metal surfaces.	Corrosive. Dangerous for the environment. Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.	Have eye wash bottle or eye rinse at the work place. Avoid contact with eyes. Provide sufficient air exchange and/or exhaust in work rooms.	Keep container tightly closed in a dry and well-ventilated place. Store at room temperature in the original container.	Dispose off as special waste in compliance with local and national regulations.
		Gardoclean S 5121: Cleaning agent for metal surfaces	May be corrosive to metals. Causes severe skin burns and eye damage.	Provide sufficient air exchange and/or exhaust in work rooms. Ensure that eye flushing systems and safety showers are located close to the working place. Avoid contact with skin and eyes. Normal measures for preventive fire protection.	Store in a place accessible by authorized persons only. Store at room temperature in the original container. Keep container tightly closed in a dry and well-ventilated place. Avoid contact with amphoteric metals (e.g. aluminium, lead,zinc). Do not store near acids	Dispose of in accordance with local regulations. Contaminated packaging should be emptied as far as possible and disposed of in the same manner as the substance/product.
		GARDOLENE D 6812: Surface treatment agent	Causes severe skin burns and eye damage. May cause an allergic skin reaction. Harmful to aquatic life with long lasting effects.	Do not return residues to the storage containers. Provide good ventilation of working area (local exhaust ventilation if necessary). Avoid inhalation of vapour and spray mist. The workplace should be equipped with an emergency shower and eye-rinsing facility. Avoid contact with skin and eyes. Keep away from food, drink and animal feeding stuffs. Warn users about safety measures and precautions to prevent accidents. The substance/product is non-combustible. The relevant fire protection measures should be noted.	Suitable materials for the storage containers: Polypropylene (PP), Polyethyleneterephtalate (PET), Low density polyethylene (LDPE), High density polyethylene (HDPE), tinned carbon steel (Tinplate), Carbon steel (Black plate). Further information on storage conditions: The entrance to storage rooms is to be granted only to appropriately trained personnel. Keep only in the original container. Keep in a cool, well-ventilated place. Avoid direct sunlight. Protect from frost. Keep away from heat. Storage temperature: 0 - 40 °C	Observe national and local legal requirements. Contaminated packaging should be emptied as far as possible and disposed of in the same manner as the substance/product.
		ECODRAW: Metalworking fluid	Causes Skin Corrosion/Irritation	Contains amines. Do not add sodium nitrite or other nitrosating agents, which may form cancer causing nitrosamines. Avoid contact with skin. Wash hands thoroughly after handling.	Store in original tightly closed container. Avoid contact with oxidizing agents. Store away from incompatible materials.	Discharge, treatment, or disposal may be subject to national, state, or local laws. Dispose of waste at an appropriate treatment and disposal facility in accordance with applicable laws and regulations, and product characteristics at time of disposal. Empty containers should be taken to an approved waste handling site for recycling or disposal.
		SULPHURIC ACID 1% (250mls): Laboratory chemicals.	Corrosive. Causes severe burns.	Avoid contact with eyes, skin and clothing.	Keep container tightly closed. Keep container in a cool, well-ventilated area.	Waste must be disposed of in accordance with federal, state and local environmental control regulations.
		SULPHURIC ACID 9% (250mls): Laboratory chemicals.	Strongly corrosive to body tissue and slightly toxic by ingestion. Target organs: Respiratory system, eyes, skin, teeth This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).	Use with adequate ventilation and do not breathe dust or vapor. Avoid contact with skin, eyes, or clothing. Wash hands thoroughly after handling	Store in Corrosive Area (White Storage) with other corrosive items. Store in a dedicated corrosive cabinet. Store in a cool, dry, well-ventilated, locked store room away from incompatible materials.	Check with all applicable local, regional, and national laws and regulations. Local regulations may be more stringent than regional or national regulations. Small amounts of this material may be suitable for sanitary sewer disposal after being neutralized to PH 7.
		CHROMIC ACID (Chromium trioxide): Laboratory chemicals.	May cause fire or explosion; strong oxidizer, Toxic if swallowed, Causes severe skin burns and eye damage, May cause respiratory irritation, May cause an allergic skin reaction, May cause allergy or asthma symptoms or breathing difficulties if inhaled, May cause genetic defects, May cause cancer, Suspected of damaging fertility, Causes damage to organs through prolonged or repeated exposure, Fatal in contact with skin or if inhaled, Precautionary	Wear personal protective equipment/face protection. Do not get in eyes, on skin, or on clothing. Use only under a chemical fume hood. Do not ingest. If swallowed then seek immediate medical assistance. Do not breathe (dust, vapor, mist, gas) Avoid dust formation. Keep away from clothing and other combustible materials.	Keep in a dry, cool and well-ventilated place. Keep container tightly closed. Do not store near combustible materials. Store under an inert atmosphere. Protect from moisture. Incompatible Materials. Bases. Alcohols. Amines. Ammonia. Hydrocarbons. Ketones. Acetone. Acid anhydrides. Metals. Reducing Agent. Finely powdered metals. Strong reducing agents. Combustible material.	Dispose of contents/container to an approved waste disposal plant
4	**BULK-ON**	**BESTOLIFE 2000**: Thread Compound (Pipe Dope) and Jacking grease for use in Offshore industries Mining	Causes serious eye damage/eye irritation	Do not get on skin or clothing. Do not swallow. Do not get in eyes. Handle in accordance with good industrial hygiene and safety practice, based on the results of the workplace exposure assessment Take care to prevent spills, waste and minimize release to the environment.	Keep in properly labelled containers. Store in accordance with the particular national regulations. Do not store with the products that are Strong oxidizing agents.	Dispose of in accordance with local regulation. Empty containers should be taken to an approved waste han dling site for recycling or disposal.
		BESTOLIFE 72733: Thread Compound (Pipe Dope) and Jacking grease for use in Offshore industries, Mining.	May cause an allergic skin reaction. May damage fertility. May damage the unborn child. May cause harm to breast-fed children. Causes damage to organs through prolonged or repeated exposure. Very toxic to aquatic life with long lasting effects.	Avoid contact during pregnancy and while nursing. Do not get on skin or clothing. Do not breathe dust, fume, gas, mist, vapours or spray. Do not swallow. Avoid contact with eyes. Wash skin thoroughly after handling. Handle in accordance with good industrial hygiene and safety practice, based on the results of the workplace exposure assessment Take care to prevent spills, waste and minimize release to the environment. If exposure to chemical is likely during typical use, provide eye flushing systems and safety showers close to the working place. When using do not eat, drink or smoke. Contaminated work clothing should not be allowed out of the workplace.Wash contaminated clothing before re-use	Keep in properly labelled containers. Store locked up. Keep tightly closed. Store in accordance with the particular national regulations. Store away from the following product types: Strong oxidizing agents, Organic peroxides, Explosives, Gases.	Dispose of in accordance with local regulations. Empty containers should be taken to an approved waste han dling site for recycling or disposal. Empty containers retain residue and can be dangerous. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose such containers to heat, flame, sparks, or other sources of ignition. They may explode and cause injury and/or death. If not otherwise specified: Dispose of as unused product.
		JET-LUBE™ SEAL-GUARD™ ECF™: Lubricating grease	May cause irritation. Viscous nature may block breathing passages if inhaled. Ingestion: May cause diarrhea if ingested. For hypersensitive persons, may irritate the skin after prolonged periods of contact.	No special handling precautions necessary	Do not store at elevated temperatures.	Do not incinerate. Contact waste disposal company or local authority for advice
5	**Pipe maintenance/Finishing**	**RUST VETO 4242**: Rust Preventative	May be fatal if swallowed and enters airways. Combustible liquid.	Ensure adequate ventilation. Do not eat, drink or smoke when using this product. Handle in accordance with good industrial hygiene and safety practice. Remove all sources of ignition.	Keep containers tightly closed in a dry, cool and well-ventilated place. Keep away from open flames, hot surfaces, and sources of ignition. Keep out of the reach of children.	Dispose of in accordance with federal, state, and local regulations. Observe all label precautions until container is cleaned, reconditioned or destroyed.
		METAL GUARD 950 (VARNISH): Clear Varnish	Flammable liquid and vapor. Causes mild skin irritation. May cause an allergic skin reaction. Eye damage. Suspected of causing cancer. Suspected of damaging the unborn child. Causes damage to organs through prolonged or repeated exposure	Use non-sparking utensils when handling this material.	Handle containers carefully to prevent damage and spillage. Avoid hot metal surface. Keep away from excessive heat and open flames. Store away from Strong oxidizing agents and acids. KEEP OUT OF REACH OF CHILDREN.	Observe all federal, state and local regulations when disposing of this substance

6. All respondents from both companies says they have format use in evaluate the risks associated with their job.

   Table 4A & 4B below shows a sample of the format the company uses in evaluating/scoring risk/hazard

Table 4A: Raw Material Risk Assessment (Scoring system)

Likelihood	
1	Never happened
2	Unlikely to happen
3	May happen
4	Likely to happen
5	Happening now/Happens regularly
Severity	
1	No harm possible
2	No health impact
3	Minor illness or injury
4	Significant illness or injury
5	Death or serious illness

Table 4B: Raw Material Risk Assessment (Matrix)

Likelihood \ Severity	1	2	3	4	5
1	1	2	3	4	5
2	2	4	6	8	10
3	3	6	9	12	15
4	4	8	12	16	20
5	5	10	15	20	25

Product Recall & Complaints

7. Respondents affirms that their company have a standard procedure for the recall of products. According to the procedure, any product (threaded pipe) found to be defective should be rejected. This is done by color-coding the threaded pipe and segregating it from the good ones. Quality control inspection is carried out on each pipe from process to process so it is each to know the exact process that the defect was. The defected pipe end will be cutoff and the threading process will be repeated. If the defect is due to the condition of the raw material used, such as expired, poor quality etc., the material will be segregated, reported and documented.

8. Respondents stated that there is a complain Form that is designed in processing complaints.

Internal Audit Program

9. Respondents from both company stated that their company has internal audit program for the various departments.

10. Respondents from both company affirms that there is a written report produced after each audit. Furthermore, respondent from "Company A" was able to prove that apart from the written report, their company have an ERP system that contains all audit report both internal and external audit report. This report can be access at all time

    All audit report from both company has a standard format, it contains specific checklist and questionnaire designed by the quality assurance department in line with ISO standard requirement for pipe threading process.

11. The internal audit program for both company, covers all aspect of the safety and quality processes, this includes the following: hygiene, traceability, HACCP, batch recall and withdrawal test.

12. From both company surveyed, it was established that internal audits are conducted twice yearly by authorized quality personnel from within the company that has undergone training as lead auditors while external audits are conducted by third-party auditors that are sufficiently well qualified to assess compliance with quality requirements.

Quality Control

13. From the survey, it was evident that in both company, for each batch of raw materials procured, each were delivered with a full certificate of analysis sometimes in advance and at other times by accompanying the product/raw material. However, it was noticed that this is mainly applicable for imported raw materials; most of the locally purchased raw materials are not delivered with the certificate of analysis. The local materials are still accepted but that is only after a through quality inspection is carried out on each batch of the product in the laboratory.

14. The quality assurance personnel from both company are officially responsible (qualified person) for approval of materials supplied while the warehouse (store) supervisor or head of department are responsible for the release of products for operational consumption.

    In both company surveyed, the quality assurance personnel's responsible for material approval are holders of B.Sc. Degree or HND in science related field

and are trained pipe inspectors. While the warehouse (store) supervisor or head of department are responsible for the release, of products for operational consumption are B.Sc. or M.Sc. in management sciences and have undergone several warehouse management trainings e.g. chemical management training.

15. Both company do have standard procedure for validation of materials used in their operations. In "Company A" the procedure is titled: "Material Inspection and Control" while in "Company B" the procedure is titled: Incoming Material Inspection".

16. "Company A" has an ERP system that helps in controlling materials status. The system contains all vital information of each materials such as date of production, Expiration Date (Shelve life), batch no, Name of manufacturer, etc. it give notice of expiration using colors two months before the final date of expiration with alarm.
"Company B" controls their material expiration using a locally designed Microsoft Access database that also alert them when a material is about to expire.

17. Both company have a batch record for every batch, undersigned and dated, reporting rate of production, registration of production steps, registration of control and release by the qualified person. The both company use an ERP called SAP.

Batch records and other operational records are kept under controlled access. All the data are recorded in SAP and can only be accessed by persons with registered Login Details. Also noted is that, each persons with login details has specific permission to what he/she is authorized to access in the system.

Batch records and other operational records are retained for as long as the ERP system (SAP) is being used in the company since it is an electronic database (Software). It can be accessed even several years after production. This is because of the sensitivity of were all the threaded pipe is used on (i.e. the oil field). An error could develop in future in their client oil field that the client may want to attribute to the finished product defect; this record serves as protection for them in case of any litigation against them.

18. Both company have two different internal quality laboratory. They are the Metrology Laboratory and General Science laboratory. The laboratories are used to conduct materials analysis to evaluate material quality and provide the necessary insight to improve performance & resolve failure or contamination issues.

The list and specifications of some analyses done internally in the labs are:

- **Microscopy**: Microscopy analysis is essential to gain an understanding of the microstructure or nanostructure of materials, chemicals or products. Data from microscopy analysis is important to progressing your research and product development programs, conducting failure analysis where the product or material has failed or resolving contamination issues in manufacturing or other parts of the supply chain.
- **Surface analysis:** Surface and structural materials analysis can drive understanding of the microstructural characterization of materials. The microstructure or surface properties of a material is typically influenced by its chemical composition and production or processing route and these properties can impact the chemical, physical and mechanical properties and hence its function and performance in the intended application or formulation
- **Mass spectrometry**: Mass spectroscopy is used to detect and identify unknowns, mixtures, chemical structures, and more.
- **NMR analysis**: Nuclear Magnetic Resonance Spectroscopy (NMR) provide analytical data regarding the type, quantity and arrangement of atoms in chemical systems, liquids and solids. Wide ranges of samples are tested. NMR analysis applications includes: Chemical structure analysis of liquids and dissolved solids, DE formulation of products, Quantification of mixture components, Kinetic and temperature studies of reaction mixtures, Characterization of polymers, including structure, co-monomer ratios, end groups, average molecular weight (MW).

- **Thermal analysis**: It involve measuring thermal properties of materials, including polymers, plastics, composites, laminates, adhesives, coatings, organic materials, rubber, petroleum, chemicals, biological samples, and others. Thermal tests for the determination of endotherms, exotherms, phase transitions, weight loss on heating or cooling and dimension changes are performed.

19. Respondents from both companies stated that all the test for analytical control are carried out in their internal laboratory since the company internal laboratory is well equipped with modern test equipment's for their type of operations.

20. Both company affirms that since the commencement of their operations here in Nigeria, they have recorded

several cases of threaded pipe rejection resulting from defeat in raw materials used and other operational issues.

From their response in both companies, pipe rejections have been recorded in virtually all the operational process of the job at one time or the other. These includes operational processes such as Swaging and sizing, Pipe threading, Phosphating, Buck-on, Pipe Finishing and Maintenance

Please see Table 3 below for details of some of such rejection pointed out by the various respondents.

Table 3: Details of courses of threaded pipe rejection due to materials (source: Surveyed companies)

S/NO	Operational Process	Courses of Threaded Pipe Rejection	Preventive Solution
1	Swaging and sizing	Excess mixture of Renoform SVO L Swaginging dope with water	The mixing raitio of Renoform and water should be carefully and strictly
2	Pipe threading	Poor quality of insert used in the threading and poor quality of Aquasol Metal Fluid used as a cooling agent.	Only good quality of tools and materials should be purchase and used. Also all required Lab test should be carried out befor accepting
3	Phosphating	Use of expired Gardobond-Additive H 7204 as an additive for surface treatment on the pipes. Also wrong storage system of some of the chemicals used in the phosphating process that required special means of storage.	Proper tracking system of the status and conditions of each raw material should be followed and segregation of any expired material to prevent being mistaking used in the operational process. Furthermore, materials storage should be strictly as recommended by the manufacturer stated in the Material Safety Data
4	Buck-on	Poor quality of Bestolife 72733 used as thread Compound and Jacking grease.	Only good quality of materials should be purchase and used. Also all required Lab test should be carried out befor accepting and using them
5	Pipe Finishing/Maintenance	Quality of the Metal Guard (VARNISH) used for finishing process is below client specification	Purchase and used materials that meets client specifications. Also all required Lab test should be carried out befor accepting and using them

5. CONCLUSION AND RECOMENDATIONS

5.1 Conclusion

The quality of raw materials used in production is vital in determining the quality of the product or finished goods; this also applies to the finished threaded OCTG pipes used in the oil industries. Poor management of industrial raw material has significant negative effect on finished product in an OCTG pipe threading operation. Raw material management and usage has lots of associated or potential risk in an OCTG pipe threading operation.

Each batch of raw materials procured, are often delivered with a full certificate of analysis in advance or accompanying the product/raw material.

From the internal company records/procedures sited, the hazards having high-risk rating and above were reduced to a level considered As Low as Reasonably Practicable (ALARP) when the control measures were applied as listed in Table 2 above, thereby reducing the occurrence of injury or disease in the workplace.

The use of Material safety Data Sheet (MSDS) in managing materials at workplace is key in reducing the associated risk and in eliminating the hazards. It is important that all recommendations in handling and storing the various raw materials for operations as listed in the MSDS should be strictly adhered for maximum utilization.

Management of industries has key role to play to achieve maximum utilization of their operations raw material. This they can achieve by ensuring that all operational procedures are in place and strictly implemented by staffs, providing adequate standard storage facility (Warehouse) including warehouse with special futures for materials with special storage requirement, training of all operations personnel especially the Warehouse personnel on the material management etc.

The strength of this research lies in the fact that it is real case scenario, the result from fieldwork observations, at such it has the potential of being able to enhance or promote the way industrial raw materials are managed, also to mitigate associated hazards/Risk for maximum utilization if the findings and recommendations are effectively implemented.

5.2 Recommendation

1. The researcher recommends that more material storage warehouses should be constructed in both companies, specifically for materials with special features such as temperature regulation, reactant materials, corrosive etc.
2. The Researcher recommends that trainings on various applicable laws and regulations (International, National and Local) should be periodically conducted to educate the workforce of what is expected. Furthermore, the management of both companies should improve in their Disposal Considerations, it was noticed that they do not properly manage how waste and empty containers from used product are disposed as recommended in the various material safety data sheet. The waste generated should be disposed properly as recommended.
3. Careful tracking (Follow-up) of material status, e.g. expiration date, will help in reducing the rate of product rejection resulting from materials used. Furthermore, they should not depend totally on materials certificate from the material manufacturers, they should strictly adhere to carrying out their own internal laboratory test and inspected on all purchased materials as stated in their company procedures.

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