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The Achievement of Safety Management in Arab Potash Company

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ABSTRACT

The Arab Potash Company (APC) is one of the largest companies in Jordan. This company is suffering from lost time injury and accidents due to a lot of different accidents and several hazards associated with complicated location of the work environment. This work discusses the main parameters representing the risk and safety measures in this company, such as accident frequency, severity indictor (FSI), accident frequency rate (AFR) and accident severity rate (ASR), since 1998 to December 2014. The AFR, ASR and FSI have dropped from 5.51, 679 and 0.78 to 0.18, 6.5 and 0.3, respectively. The decline in these factors may be considered satisfactory since 2004 due to commitment and implementing of new and different safety polices procedures and issues of international safety standards (OHSAS-18001 2007) by the new leaderships of this company. The results have shown that the company has achieved four million working hours with negligible lost time injury in 2012 and reaches the same achievement in 2013 and up to December 2014.

Keywords: Accident severity, safety polices, leaderships, lost time injury, accidents.

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Abbreviations

RCD, Residual current device; **APC,** Arab Potash Company; **FSI,** frequency severity indicator; **AFR,** accident frequency rate; **ASR,** accident severity rate; **KPA,** key products audit; **SWR,** safety work request; **LTI,** lost time injury.

INTRODUCTION

The idea of the Potash project was based on the Potash Plant located on the north-western shores of the Dead Sea during the British Mandate. The old plant was destroyed but the idea remained alive and a Pan Arab company was formed in 1956 to implement a project for the production of Potash using the minerals of the Dead Sea. The site is located 110 km south of Amman and 200 km north of Aqaba. The site is a Solar Evaporation Pond System of an area of 150 square kilometers and processing plants for the ore (APC Arab potash Company –Jordan).

The investment in the original project including substantial infrastructure was nearly 480 million USD. Financing was obtained through loans from international finance institutions and aid agencies as well as Arab development funds. The project began in 1976 with tests and experiments to determine the parameters of various technologies and ideas in a very hostile environment. Construction began in 1979 and was completed in 1982. At the end of construction, about 117 km of seepage proof dykes were built (other dykes built later on). These were more than 8 m wide at the top and were an engineering challenge to be built on top of a non- stable sea bed. The excavation carried out during the construction period was of a colossal magnitude, 16 million cubic meters of earth material was displaced.

Potash production began in 1983 and has since progressed with various schemes aimed at optimizing and expanding this production. The initial plant was built to a capacity of 1.2 million tonnes of product. This was expanded in the late eighties to handle 1.4 million tonnes and key modifications were undertaken with the Solar System to enhance the production of the ore accordingly. A second plant based on different technology and of a capacity of 0.4 million tonnes was built in 1994 and this brought the total production capacity to 1.8 million

Figure 1. Solar evaporation system.

tonnes. The cost of the new plant was around 120 million USD. There are plans to expand, through further optimization, the existing plants. Projects are underway to expand the Solar Evaporation System and construct another plant and thus raise the capacity to 2.4 million tonnes of product after the year 2008.

The capital of the Arab Potash Company is 83.318 million Jordanian Dinars. It has a concession from the Jordanian Government to exploit, manufacture, and market the mineral resources of the Dead Sea, until 2058. The Arab Potash Company employs over 2000 personnel and has offices in Amman, Safi and Aqaba. It owns extensive housing and recreational facilities near its plants, and in addition, provides the surrounding region with assistance in social, medical, economic and vocational development.

Process in APC

At the heart of the Ghor El-Safi site are a 112 km^2 solar evaporation ponds system and ore processing plants. The brine from the Dead Sea is pumped at a yearly average rate of 350 million into the solar evaporation system by main intake pumping station, where the initial concentration process is undertaken at the salt ponds where NaCl deposits. The remaining brine is pumped into the Carnallite ponds, to precipitate the raw Carnallite (Figure 1).

The precipitated raw Carnallite is the raw material for producing potash. It is precipitated as mixture of Carnallite ($KCl.MgCl_2.6H_2O$) and NaCl. This bed is harvested as a slurry from beneath the brine and delivered to booster pumps on the dikes and then to the refinery through floating pipes (Figures 2 and 3).

The raw Carnalities is harvested and pumped to three refineries. The original plant employs hot leach technology to process the Carnalities to extract potash, but the newer facilities employ cold crystallization. Crystallization is an important operation in the chemical industry, as a method of purification and as a method of providing crystalline materials in the desired size range. In a crystal the constituent molecules, ions or atoms are arranged in a regular manner with the result that the crystal shape is independent of size, and if a crystal grows, each of the faces develops in a regular manner. The presence of impurities will, however, usually result in the formation of an irregular crystal (Arab Potash Company, Jordan).

The crystallizer is a draft tube-baffle design; the agitator circulates the crystal slurry from the bottom to the evaporation surface (top) through the draft tube. This feature allows the crystals and the supersaturated brine formed at the surface to come into almost immediate contact, enhancing crystal growth. And the principles of precipitate the content of ''KCI" is to reduce the solubility of solution suddenly by cooling the brine suddenly by condensers and make vacuum inside the crystallizer. To accomplish this, it is required that:

1. Ejectors: to achieve the desired vacuum, depends on the flow of the steam through the venture to Rarefaction the pressure inside the crystallizer to absorb vapor.
2. Condensers: cools the solution inside the crystallizers; here, the mother liquor returns to hot leaching area in the first three crystallizers. Using "barometric condensers'' in addition to heating the mother liquor, saves 183 million Btu/h (51% of the heat required) and raises the mother liquor temperature from 49 to 81°C. The second source of cooling is the Salvanite thickener under flow and Carnality thickener over flow.

Operating procedure

The slurry from the hot thickener enters the crystallizer

Figure 2. Pumping station.

Figure 3. The refineries.

from the bottom and it is the solid potash and its temperature is about 90°C (19% KCl and 12% NaCl) and with another unsaturated feed from the bottom also. In addition, a fresh water feed to keep the level in the crystallizers is constant and recovers 70% of the amount of evaporation.

The cooling slurry is added from top, and insures good distribution of the penetrated pans. (Figure 3).

Subsidiaries and affiliates

APC's goal is to develop and utilize the treasures of the Dead Sea. To accomplish this goal, APC has implemented new projects through the establishment of subsidiary and affiliate companies to own, build, operate and manage several Dead Sea ventures.

Procedures implemented by top management

This company suffered from lost time injury and accidents due to different types of accidents and hazards associated with complicated location of the work environment. The present work will discuss the following parameters such as accident frequency and severity

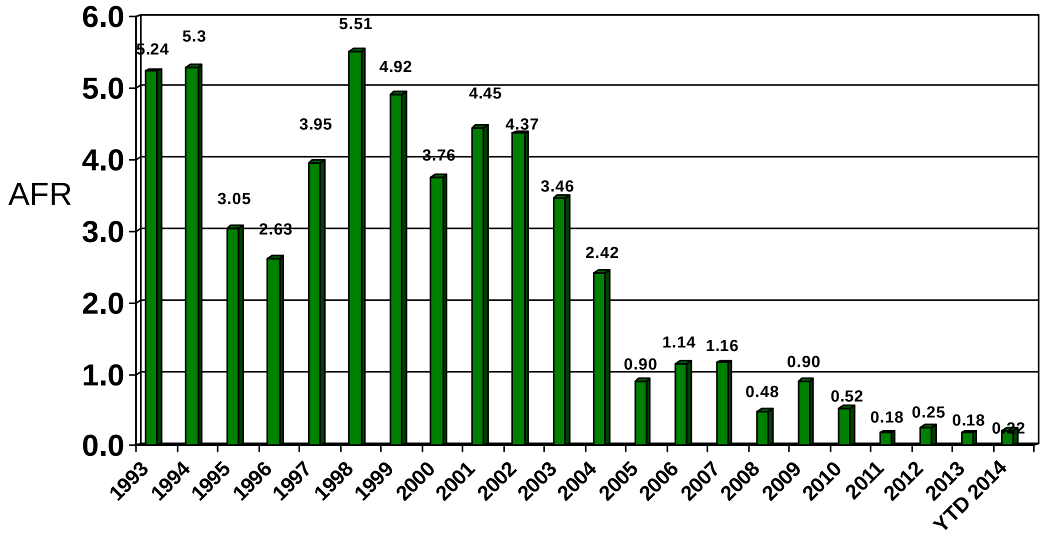

Figure 4. APC annual accident frequency rate (AFR) LTA's per 200,000 Man-Hours Worked.

indictor (FSI), accident frequency rate (AFR) and accident severity rate (ASR) since 1998. These factors have reduced tremendously after applying the following procedures and issues:

1. Applying a safety management system according to the best and recent international safety standard (OHSAS-18001:2007).
2. Exemplary commitment, involvement and dedication to safety by Top Management in APC (leadership)
3. Safety KPA (key producers audit)
4. Electrical safety working committee (Appendix 1)
5. Crane and hoist inspection committee (Appendix 2)
6. Task risk assessment (TRA, Appendix 3)
7. Applying the safety forums designed for APC trucking drivers, supervisors and superintendents.
8. Development and applying of an effective safety work order procedure such as the Safety Work Request (SWR, Appendix 4).
9. Effective taproot investigations and corrective actions.
10. Enforcement of SMART objectives development by managers and superintendents for safety, quality and environment.
11. Instilling, growing and sustaining a vibrant safety culture.
12. Integrating the safety culture in Islam with the safety culture in the company such as APC Quarterly Magazine.
13. Developing and implementing an effective safety procedure to monitor, control and improve the safety performance of APC service providers.
14. Applying safety incentives scheme.
15. Quality, environment and safety management systems' integration.
16. Effective G M-Management review meetings.
17. Improved safety inspections and audits programs.
18. Effective safety committee meetings
19. Effective emergency (fire, first aid and rescue services).
20. Improved safety training for regular work and for emergencies.
21. Improved housekeeping performance monitoring and control procedure using the 5S criteria-(developed by Hiroyuki Hirano).
22. Lessons learned from PCS incidents.

DATA ANALYSIS AND DISCUSSION

The accident frequency and severity indicator (FSI) is calculated as follows (Algaralleh, 2014):

$$FSI = \sqrt{\frac{AFR}{ASR}\ 1000}$$

Where,
AFR– accident frequency rate = Accidents per 200000 Man Hour Work
ASR– accident severity rate = Accidents per 200000 Man Hour Work

Figure 4 shows the relationship between AFR and years (from 1993 to 2013). It is clear from this figure that the Accident Frequency Rate (AFR) is showing three stages, firstly fluctuating values between 5.51 (year 1998) to 2.42 (year 2004). This stage represents the project before implementing the new rules and issues by the new leader ships of the company. While the second stage started at year 2005 at which the AFR reduced to 0.9 then a little up down value till year 2010 with value of 0.52. The third stage at year (2011 to 2013) at which AFR of values

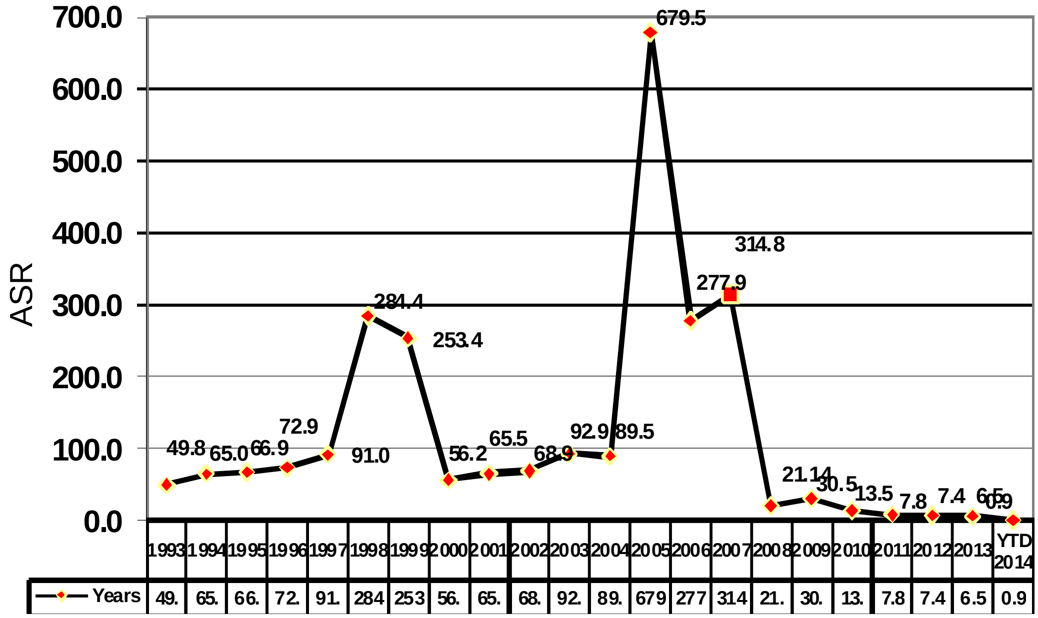

Figure 5. APC annual accidents severity rate variation (ASR) during 1993 to YTD 2014.

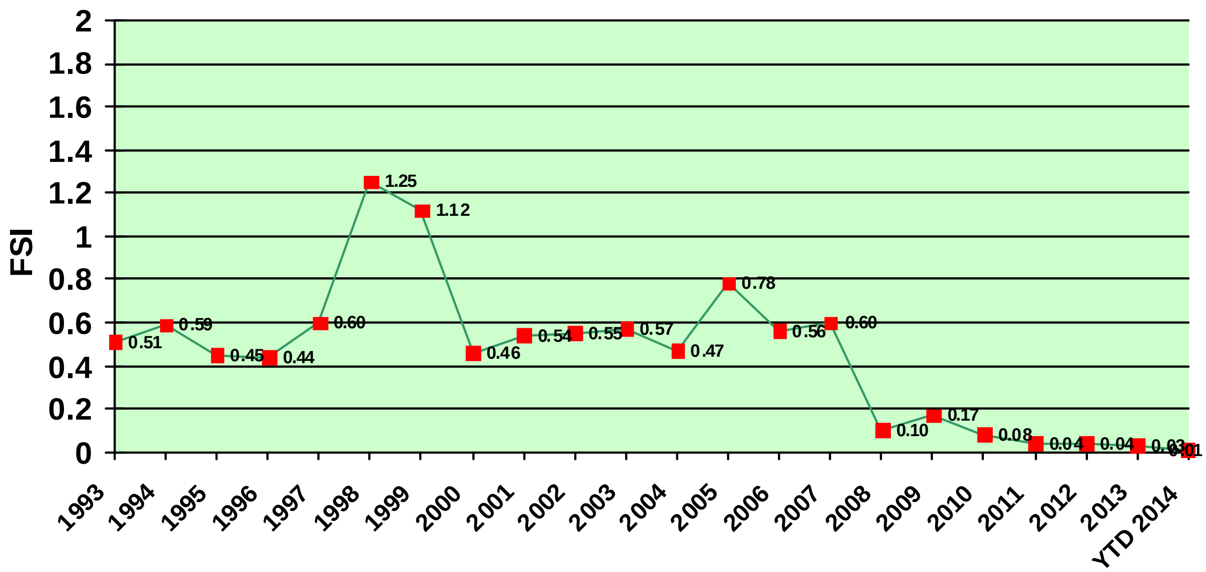

Figure 6. APC annual accidents frequency severity indicator variation (FSI) during 1993 to YTD 2014.

around 0.18. These values (that is, after year 2011) can be considered negligible values which confirm the impact of applications of the right safety and risk management in company, while Figure 5 illustrates the plot of ASR (Accident Severity Rate) against years (from 1993 to December 2014). The figure shows that the values of ASR can be divided to five stages; the first is between 1993 and 1997 with ASR values between 49.8 and 91.0; the second stage between 1997 and 2000 with jump in ASR to 284.4; the third with ASR between 56.2 and 89.5. The fourth stage between 2004 and 2008 has the maximum record of ASR especially at year 2005, where ASR = 676.5 from the above stages which extended from year 1993 to 2008 exhibit an extreme fluctuating in value of ASR and this may due to the ambiguous in safety regulations of the irresponsibility of the leader ship management. While the fifth stage (after 2008) which started in synchronize with the new leadership and management is reflected clearly on results, in which the values of ASR started to decline from 21.14 to nearly zero in 2014. The same trend can be seen in Figure 6 in which FSI is plotted against years.

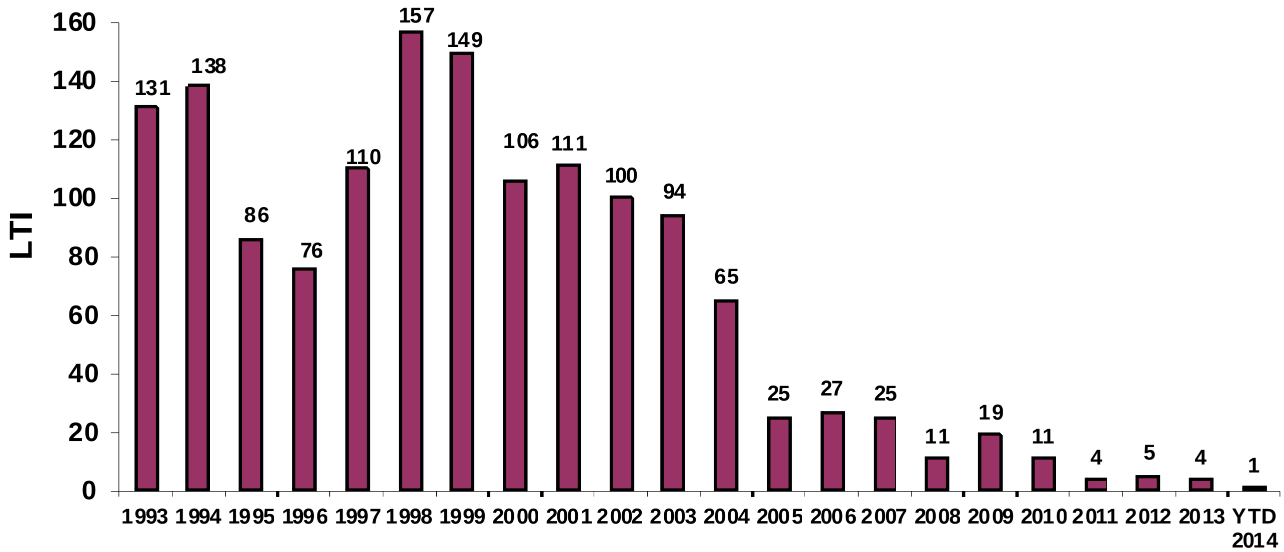

Figure 7. Lost time injury (LTI) incidents from 1993 to YTD 2014.

Table 1. APC LTI for the years 2013 and 2014 for the period from 1st January up to 14th April.

Lost time injury		2013	December 2014
Workplace in APC	LTI	4	1
	Days lost	149	24
Out of work place in APC	LTI	2	0
	Days lost	26	41*
Total	LTI	6	1
	Days lost	175	* 65

Figure 7 shows the relation between the lost time injury (LTI) against the years for the same period of the above figures. This figure shows a clear reduction in LTI after 2004 until it reaches approximately zero in 2014. A sample of data are shown in Table 1 for 2013 and 2014 and the related values of (LTIFR) FSI and RIFR also show a great reduction in LTI; in 2013 it was 175 days while in 2014 it reduced to 65 days (that is, 110 days reduction in one year). From the results above it is easy to say that when the leadership adopt new, updates and advanced rules issues of safety and risk management can reduce the LTI to negligible values which will be reflected in profits and success of the company in competition with others (Ian Glendon et al., 2006; Jardine et al., 2003; Rio Tinto 2005; Aven, 2003; Standards Australia, 2006; Zohar and Luria, 2003; Zwerling, 1993).

APC safety measures for the same period in Table 1:

1. Lost Time Injuries' Frequency Rate (LTIFR) = 0.18 => this is the same record hit in 2011
2. Frequency Severity Indicator (FSI) = 0.03 => this is an unprecedented record
3. Recordable Injuries' Frequency Rate (RIFR) = 0.57 => this is an unprecedented record
4. Product Haulage Trucks Accidents = 3

CONCLUSIONS

Risk management is the process of identifying and evaluating risks associated with activities and operations of the company developing means to control, reduce or delimitate those risks, as well as finance them. These risks include natural disasters, illness, injury, and loss of prosperity resulting from unsafe practices or conditions as well as financed cost of these losses. The company attempts to eliminate or control these through hazard identification and correction, accident prevention, training, installation life safety systems in buildings, fire protection systems and other various measures on an individual level. Risk management is the effort by each employee to make the fullest use of his or her personal capabilities to eliminate or reduce hazards in his or her working environment (Zwerling, 2005; Zacharatos et al., 2005; Yukl, 1998; Zhu et al., 2000).

The mission of new leaderships of the APC are to promote safety and accident prevention manage the protection of company assets, both human and financial, minimize legal liabilities, and support compliance with environmental and safety regulations. Thus, the new leadership has succeeded in reducing AFR, ASR and FSI to approximately negligible values and has implemented the recent international safety measures and regulations. Therefore, the company has gained about four million working hours with a negligible lost time injury (LTI) in 2014.

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APPENDIX 1

Safety producers in Arab Potash Company for Electrical Safety Working old ESW Committee.
Hand Tools, Extension Cords and RCDs Check lists Usage Procedure Reference Documents:
1. Form (A): user check list.
2. Form (B): electrical section check list.
3. Form (C): electrical safety working committee check list.

The procedure

1. It is the responsibility of the section owning the hand tools, extension cords and RCDs to TAG them as per their own tagging system.
2. After hand tools, extension cord and RCDs are tagged, then they shall be sent to the related electrical section to decide which of them can be used safely and to carry out the necessary repair as follows:

a) Repair hand tool if failure is maintainable. Otherwise, recommend writing off accordingly.
b) Replace RCD if it is inoperable when pushing the test button. Otherwise, apply maintenance as necessary.
c) Replace deteriorated or broken plugs or sockets. Otherwise, apply maintenance as necessary.
d) Replace hand tool or extension cord cables if:

i) The cable has joints.
ii) Cable insulation resistance below standard.
iii) Signs of deterioration or damage which could impact performance or safety are present.

2. It is the responsibility of the department owning the hand tools, extension cords and RCDs to send them quarterly to the related electrical section for periodic check.
3. It is the responsibility of the user of the hand tool, extension cord and RCD to inspect and test them before each use as per the attached check list form (A) and to keep them away from salt dust, brine leaks and mechanical impacts.
4. If hand tool, extension cord and RCD pass the inspection and test, then the user can use them accordingly.
5. If hand tool, extension cord and RCD failed, then it is the responsibility of the user to send them for further checks and repair by the related electrical section.
6. In both cases (pass/fail), the check list (form A) must be filled and signed. One copy shall be kept with the user and the other copy shall be kept in the LOG book.
7. Upon the request of the owning section, the related electrical section shall carry out further inspection and repair for hand tools, extension cords and RCDs as per point 2 above and the attached check list form (B).
8. In both cases (pass/fail), the check list (form B) must be filled and signed. One copy shall be kept with the electrical technician and the other copy shall be kept in the LOG book.
9. Electrical safety working committee will apply spot (non periodic random) audits using check list form (C) for sections' hand tools, extension cords, RCDs and LOG books. Non compliance will be reported to DGMT through the first copy of form (C). The other copy shall be kept in the LOG book.

TEM	Daily by Operator	Monthly by qualified person or designee	Annually by Hoist & Crane Designee or manufacturer	Deficiencies to look for	Comments or Notations
Drums, sheaves, sprockets	x		x	Cracks, excessive wear	
Pins, earings, shafts, ears, rollers, locks & clamps			x	Excessive wear, cracks, distortion, corrosion	
Brake System	x		x	Excessive wear, drift, will not hold load	
Electrical Apparatus			x	Pitting, loose wires	
Contactors, limit switches, pushbutton stations			x	Deterioration, contact wear, loose wires	
Hook retaining members (collars, nuts) & pins, welds, or rivets			x	Not tight or secure	
Supporting structure, rails, trolley and other load bearing trolley components	x		x	Continued ability to support imposed loads Bent Hangers, loose hardware	
Warning Labels	x		x	Removed or illegible	
Pushbutton markings	x		x	Removed or illegible	
Capacity Markings	x		x	Removed or illegible	
Below hook lifting attachments. Integrity of slings and other lifting devices*.	x		x	Worn, bent, cracks, damage Improper Operation Improper Labeling	
Fire Extinguishers (cranes only)	x			Fire extinguishers not present Inspections not current (within 1 year)	

Appendix 2

Crane and Hoist inspection checklist
Section: Inspector Name
Type: Tag No.: Size: Capacity:

Item	Daily by Operator	Monthly by Committee	Annually by Outside third party	Deficiencies to look for	Comments or notations
All functional operating mechanisms	X	x	x	Maladjustment interfering with operation Excessive wear of components	
Controls	X	x	x	Improper operation	
Safety Devices	X	x	x	Malfunction	
Limit Switches	x	x	x	Check operation with no load	
Hooks	x	x	x	Deformation, chemical damage 15% in excess of normal throat opening 10% twist from plane of unbent hook Cracks	
Safety Latches	x			Deformation or inadequate operation or removed	
Load-bearing ropes	x	x	x	Improper dead-ending, deposits of foreign material, less than 2 full wraps of rope on hoist drum when hook is fully lowered.	
Load-bearing chain	x	x	x	Wear, twist, distortion, improper dead-ending, foreign material (e.g. weld splatters) Stretch	
Bolts, nuts, rivets	x	x	x	Loose or missing rivets	

REMARKS:			
Inspection code intervals:			
	D	daily	
	M	monthly	
	P	periodically	
Date of Safety Inspection:			Signature of Inspector:

Appendix 3

The Arab Potash Company (APC) enhances the risk assessment process after 2006. This is achieved by removing nearly all the hazard and reducing the level of risk by adding precautions or control measures, as necessary. In APC many producers have been established by creating a safer and healthier workplace. The step that took place includes the following:

1. Risk assessments which include identify hazards, analyze or evaluate the risk associated with that hazard, and determine appropriate ways to eliminate or control the hazard.
2. The way of doing a risk assessment:

a) Evaluate the likelihood of an injury or illness occurring, and its severity,
b) Consider normal operational situations as well as non-standard events such as shutdowns, power outages, emergencies, etc.
c) Review all available health and safety information about the hazard such as MSDSs, manufacturers literature, information from reputable organizations, results of testing, etc.
d) Identify actions necessary to eliminate or control the risk.
e) Monitor and evaluate to confirm the risk is controlled.
f) Keep any documentation or records that may be necessary. Documentation may include detailing the process used to assess the risk, outlining any evaluations, or detailing how conclusions were made.

3. In APC the hazards identified by the following:

a) Look at all aspects of the work,
b) Include non-routine activities such as maintenance, repair, or cleaning.
c) Look at accident / incident / near-miss records.
d) Include people who work "off site", on other job sites, drivers, etc.
e) Look at the way the work is organized or "done" (include experience and age of people doing the work, systems being used, etc.
f) Look at foreseeable unusual conditions (for example: possible impact on hazard control procedures that may be unavailable in an emergency situation, power outage, etc).
g) Examine risks to visitors or the public.
h) Include an assessment of groups that may have a different level of risk such as young or inexperienced workers, persons with disabilities, or new or expectant mothers.

4. In APC the hazard was controlled by elimination (including substitution), engineering controls, administrative controls, and personal protective equipments.

Appendix 4

Ser.	W.R #	Requested section	Job description	Date received	W.O #	Executing section	Due date	Status	Risk level
1	TAP	HLP PROD.	Incident APC-0000408 (APC Safi Plant- HLP- Hot thickener Area (LTI)) It is recommended studying replacement of the existing two fixed speed pumps of crystallizer feed system with variable speed pumps in order to increase the flow rate gradually and in safe mode for the operator and equipment	10-Mar-11	60508	Electrical (Process & Prod. To study)	20-May-2014	I/P... AFE issued	A
2	64636	CCP1 (Mech.)	The cooler & dryer gearboxes need to safety guard	30-Oct-13	71297	Local Contractor	30-Apr-2014	I/P	A
3	65133	HLP PROD.	Replace damaged grating beside product belt at KCL.	5-Dec-13	71952	W.S	30-Apr-2014	I/P	A
4	65258	HLP PROD.	Replace handrail, grating and beams around tail cyclones cluster at HLP.	22-Dec-13	72177	W.S	Major S/D		A
5	66136	HLP PROD.	Replace damaged grating, install strainer around pit & repair damaged cables trays in hot thk. area at HLP.	23-Feb-14	73416	W.S		N/A	A
6	66302	HLP PROD.	Replace damaged platform for O/F V/V of crystal# 6 at HLP.	4-Mar-14	73639	W.S	15-Apr-2014	I/P	A
7	66304	HLP PROD.	Replace damaged platform beside steam C/V #102 at HLP.	4-Mar-14	73644	W.S	17-Apr-2014	I/P	A
8	66389	HLP PROD.	Replace damaged platform for dryer feed belt # 60 walk way at HLP.	11-Mar-14	73789	W.S	17-Apr-2014	I/P	A
9	66390	HLP PROD.	Repair concrete of carnallite centrifuges floor at HL	11-Mar-14	73790	CIVIL	15-Apr-2014	I/P	A
10	66424	HLP PROD.	Replace damaged platform, for product thickener tunnel at CCP1.	13-Mar-14	73832	CONST.	20-Apr-2014	I/P	A