Beat the Heat! – EGA's Heat Stress Prevention Programme

Merfat Al Nuaimi[1], Budoor Al Marri[2] and Mohamed Al Bishr[3]
1. Senior supervisor
2. Superintend
3. Manager
Occupational Health and Hygiene Department, Emirates Global Aluminum, Abu Dhabi, United Arab Emirates
Corresponding author: malnuaimi@ega.ae

Abstract

Heat-related illnesses are a common risk for people working in industries with high temperature metallurgical processes, especially in hot climates. Temperatures and humidity levels in the Middle East, specifically in the United Arab Emirates, contribute to the emergence of heat related illnesses which are classified as occupational diseases. The nature of aluminum smelting activities impacts the performance and wellbeing of individuals during their working hours. This paper provides an overview of decades of Emirates Global Aluminum (EGA) experience in managing a safe working environment especially in hot conditions, controlling exposure times and making sure employees stay hydrated and healthy. The company has set a goal of zero cases of heat related illnesses during a period of five years and it was able to reduce the number of cases by 93 %, and achieved the long-lasting target of zero instances of heat related illnesses in 2019.

Keywords: Heat related illness, Heat stress, Occupational disease, EGA's Beat the Heat programme, Wet bulb globe temperature, Core body temperature, Heart rate, acclimatization, Urine specific gravity

1. Introduction

According to the World Meteorological Organization [1], the United Arab Emirates (U.A.E), recorded highest temperatures during the year of 2016; a maximum temperature of 53 °C was observed in July. It is predicted that these temperatures might increase from 2-3 °C in the coming years due to climate change. Additionally, other factors affecting this variation are air speed and humidity, depending on location within the country. Moreover, beside the geographical location of the aluminum smelters °in the U.A.E. the heat emitted from reduction cells, furnaces and other industrial equipment leads to increased risk of heat related illnesses. Heat-related illnesses (HRI) are physiological disturbances that occur when working in hot and/or humid environments resulting in disruption in the body's thermoregulatory mechanism. The types of heat related illnesses are: heat cramps, heat rash, heat exhaustion, and heat stroke.

Heat-related illnesses are considered a common but preventable occupational health disease. According to [2], the level of heat stress reported in primary aluminum smelters is significant [3]. Therefore, aluminum smelters are considered hazardous workplace based on the nature of the processes and the work demands. An assessment was carried out in aluminum smelters in Texas, United States, by the National Institute for Occupational Safety and Health (NIOSH) as requested by United Steelworkers to investigate the impact of exposure to heat during summer months on employees' performance. The survey gathered quantitative data about employees Core Body Temperature (CBT), Heart Rate (HR), Wet Bulb Globe Temperature (WBGT), Urine specific gravity and blood electrolytes. Primarily WBGT results of all the activities carried out by the employees in the smelter exceeded the American Conference of Governmental Industrial Hygienists (ACGIH), Threshold Value Limits (TVL) which increase the risk of heat related

illnesses [1]. In addition, the study revealed that several employees who experienced heat related illnesses and increased heat strain were not sufficiently hydrated and lacked acclimatization.

Heat related illnesses are classified as an occupational health disease in the U.A.E. The Ministry of Climate Change and Environment (MOCCAE) developed an adaptation programme based on global best practices, encouraging sectors and stakeholders with low to high risk levels of heat exposure, to follow the scheme to reduce the risk of heat exposure on the workers as shown in Table 1. In EGA, similar principles are followed such as, physical safeguards, risk management, knowledge, and enablers in a dedicated summer programme for a duration of six months from March to September.

Table 1. MOCCAE adaptation programme for heat exposure [5].

Type of measures	Reduced labor productivity due to heat stress Examples of potential adaptation measures
Physical safeguards	• Expand the use of enhanced technologies on heat-protective clothing and personal protective equipment for outdoor workers. • Expand accessible hydration and cooling systems. • Enhance medical surveillance and early detection of heat stress and heat stroke symptoms.
Risk management	• Enhance early warning systems and develop heat alert plans, especially for outdoor laborers during extreme heat events.
Knowledge	• Develop the capacity of clinics and health stations to recognize and respond to labor concerns on reduced productivity due to climate-related factors. • Research the effects of climate change on labor productivity. • Strengthen collaboration with the private sector on addressing heat stress as a hazard at the workplace; intensify campaigns, especially during the peak of summer. • Strengthen health monitoring of symptoms and illnesses related to heat stroke, specifically when the temperature and humidity are extremely high.
Enablers	• Strengthen enforcement of existing initiatives, such as the Safety in Heat and midday break programs; enhance monitoring and evaluation (M&E) to objectively assess results. • Revisit existing recommended standards to prevent or reduce the risk of adverse health effects of heat stress on exposed populations. • Mainstream climate change adaptation by reorienting existing programs on environmental health and occupational safety to better highlight the adaptation component of such programs.

EGA considers heat-related illness to be a significant hazard and a priority in health and safety management. Therefore, it started to develop a prevention programme to combat and prevent HRI. Initially wet bulb globe temperature (WBGT) was used to assess every activity and determine activities with potential high risk for HRI. However, there are difficulties in implementing the

WBGT Heat Stress table of ACGIH as the prevailing temperatures are significantly higher in the Gulf region than in the United States.

As of today, WBGT assessment is being used to assess new activities and new processes to determine the magnitude of risk, develop controls to minimize risk and implement programmes to prevent HRI.

In addition to WBGT, EGA over the years enhanced the programme and procedures making them comprehensive and adopted new initiatives that can support employees' performance in the smelters. This program is called "Beat the Heat"; it pro-actively consists of employee fitness to work, acclimatization, training, fluid replacement, electrolyte supply, hydration monitoring programme, shift tool-box talk, welfare facilities inspection, walkabout, core body temperature and recovery heart rate.

An annual survey is rolled out to collect employees' feedback at the end of the campaign to address gaps for next year planning. Feedback from management is gathered as well to address program improvement.

2. EGA's Heat Stress Prevention Programme

2.1 Employee Fitness to Work

Initially, EGA conducts medical surveillance of all employees during the pre-employment period to assess their fitness to work; results are used as a baseline to compare periodic health medical evaluation results throughout their career. This assessment will detect and highlight any change in employee's health status and set additional controls or work practices to be implemented to reduce the risk of developing occupational health illnesses. Moreover, for those having chronic medical conditions or have suffered from heat related illness in the previous three years must undergo a further medical surveillance and counseling before the summer. The assessments are usually performed through personal counseling in the month of March and are finalized by mid-June; this depends on the individual's medical condition and is confirmed by a clinical examination with one or more of the following based on the diagnoses:

- Urine general examination,
- Complete blood count,
- Kidney function test,
- Liver function test,
- Hemoglobin A1c (HbA1c) test,
- Electrocardiogram (ECG),
- Thyroid function test,
- Peripheral blood smear,
- Chest X-ray.

In 2021 nearly all target employee population attended the medical surveillance; Therefore, a target was set to review the list of employees with higher potential risk and update it by including conditions which require extra attention while working in high-risk areas. The generated list of findings by EGA was circulated to the concerned area management for action. Employees who were previously defined by the medical team to have had previous heat related illness and chronic medical condition were subjected to a similar control taken in the case study carried out by [3] in the smelters as part of the heat stress management programme.

2.2 Acclimatization

Acclimatization to heat exposure is important for employees to get themselves ready for the summer, and mandatory in EGA for all new employees working in a Gulf summer for the first time. A case report from Alcoa [6] is for a young male 34 years old suffering from life-threatening heat-related illness with hyponatremia. The incident occurred after the employee resumed work after seven days of absence and started intense job in high temperatures in the potlines and on the catwalks between the pots in the first hours of his duty, leading to early signs of HRI, which were treated by oral replacement at work. The employee resumed duty but by end of the shift the cramps aggravated to a severe level. The risk factors that led to this illness were: the employee was new to the job, reported to work immediately after absence, there was no adequate acclimatization, and the employee had a medical condition and was under medication.

This case report indicates similar risk factors involved with the HRI cases experienced in EGA in the past eight years including other contributing factors such as dehydration, unhealthy habits, failure to report early signs to the clinic, insufficient rest between shifts, and fatigue. Thus, the medical team has identified a guideline for four main categories to be mandatory followed up for acclimatization prior to starting or resuming duty in the area. The categories of employees who are required to be acclimatized are newly joined employees, employees back from sick leave for more than four consecutive days, employees back from annual leave for more than nine days, employees back from quarantine (COVID-19 recovered patients).

These employees are acclimatized over a period of five days; the schedule of exposure to hot environment is 20 % on day one, with a 20 % increase in exposure each additional day, until 100 % total exposure on the fifth day. There are further specific guidelines based on specific jobs, such as for Reduction potroom employees who should not perform the following tasks during their acclimatization period:

Day	**Tasks that must not be performed**
1	Any task on catwalk/gutter or pot/crucible skimming
2	Any task on catwalk/gutter or pot/ crucible skimming
3-4	Any task on catwalk/gutter.

Pot repair and cell relining employees are acclimatized through performing light to moderate operational activities on the shop floor without direct heat exposure. They can resume normal duty after two days of acclimatization and two days off. For the casthouse department the guideline is that sow casting employees should be assigned to finishing area for one week before resuming their routine assigned tasks.

2.3 Training

Heat stress training is another control which is provided during pre-placement and as a refreshing session on an annual basis before the summer. Knowledge on this subject is an essential part of the programme to raise awareness amongst all operational employees; it is also one of the main elements in MOCCAE adaptation programme to provide materials which will enable employees to recognize signs and symptoms and response to their queries.

Heat stress training is planned for all EGA employees, visitors and contractors to raise their awareness and knowledge about the HRI risk factors and prevention actions. It is deployed in face-to-face classroom, virtual sessions and online sessions. Attendance to heat stress online

training in EGA was 92 % in 2021; the course was rolled out by the end of April. In addition to that, virtual sessions were conducted upon the request of the areas to cover contractors in other languages such as in Hindi and in English for first summer employees. Moreover, an external link for the Beat the Heat course assisted those who could not attend the virtual sessions, and more than 50 employees completed it.

Moreover, EGA developed required visual artworks covering main subjects of the campaign and presented via different channels such as outdoor banners, outdoor toblerone, posters, pocket cards, intranet banner, helmet and washroom stickers. Figure 1 shows one of the posters. In addition to that, supported aids were rolled out such as a micro eLearning training course addressing one of the heat related illnesses (Heat Exhaustion) resulting in 79 % completion of the course. Due to the positive feedback a micro eLearning course has been planned for next year to address common heat related illnesses such as heat cramps. The Axonify platform will also be used as a tool to assess employee knowledge and understanding. These arrangements were done to ensure easy and fast access to information for all.

Figure 1. A poster showing 'Beat the Heat' advisory.

In 2021, EGA's Health team conducted more than 100 staff education sessions on working safely in the heat for EGA employees and contractors.

2.4 Fluid Replacement and Hydration Monitoring Program

Fluid replacement is vital for those working in the smelters to replace water and minerals loss through sweating. In the study conducted in an aluminium smelter in Texas, the laboratory reports suggested that the participants laboratory results showed significant increase in the post shift biological parameters which indicates that the employees did not drink enough fluids to keep up with the amount of water and salts lost through excessive sweating [4].

In EGA water is supplied and available to all employees and contractors through water dispensers, water fountains, bottles, and camelback. It is also supplied in the buses and at the entrance gates. Employees are reminded to drink water via email communications, toolbox talk, SMS and posters. Operational employees are advised to drink 8 to 10 liters of water during their working hours. In addition to that, to replace salts and minerals loss; electrolyte supply is available to all employees and contractors from May to September. Electrolyte is supplied in the form of individual sachets of 250 mL, Elete electrolyte drops for diabetic employees, and premixed Pocari bottles. It is

advisable to drink 500 mL of electrolyte drink for 8-hour shift and 750 mL for 12-hour shift. EGA`s Occupational Health and Hygiene (OHH) has designed water and electrolyte cycle intake instruction to make it easy for employees to follow, Figure 2.

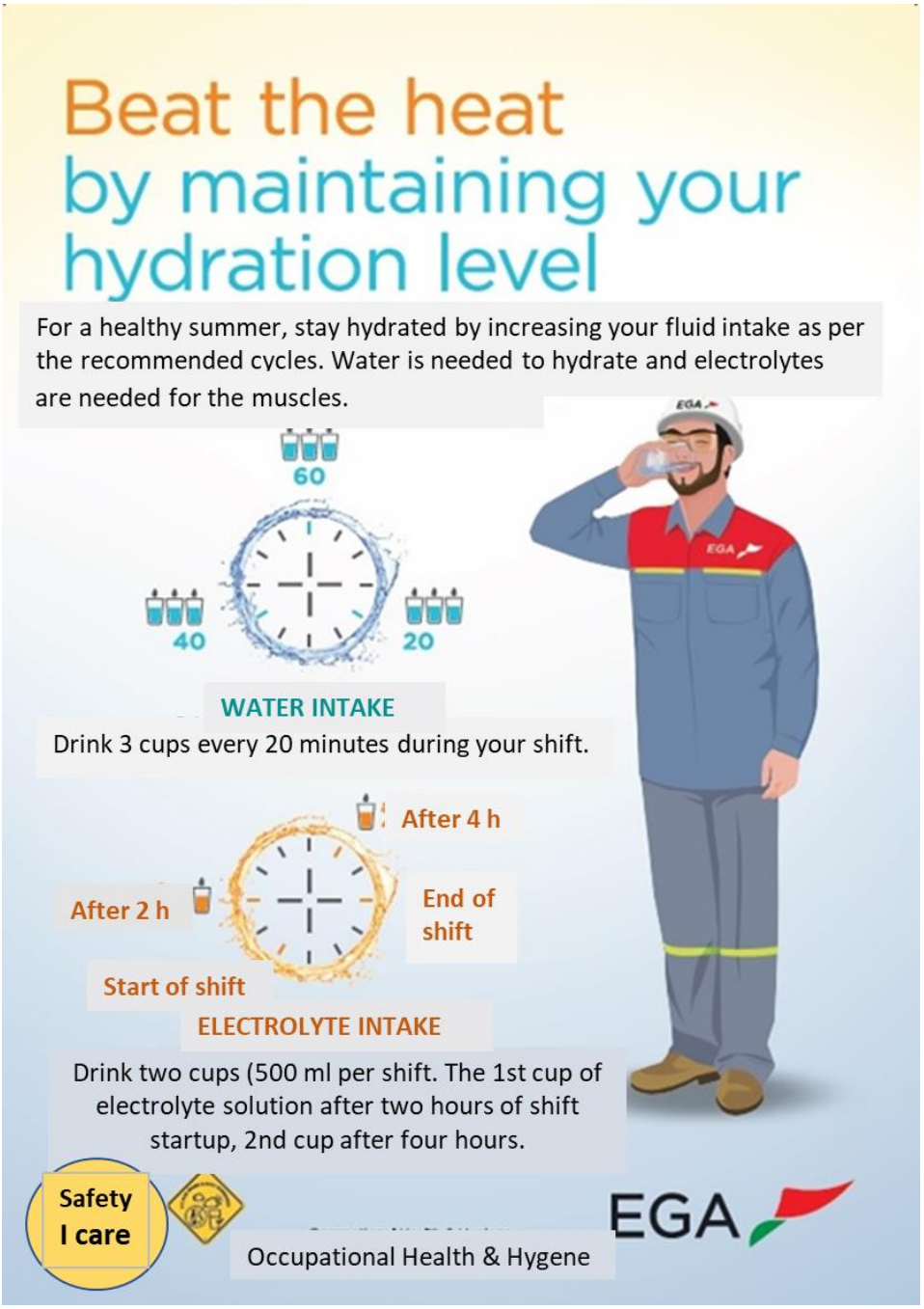

Figure 2. Water and electrolyte cycle intake.

EGA also conducts regular testing of its employees' hydration levels. Last summer, over 17 000 hydration tests were done to ensure staff wellbeing while working in hot weather.

To assess the hydration level of the employees during their working hours, a urine specific gravity test is performed for all the employees working in high-risk areas in their first morning pre-shift and mid-shift. Their results are shared with the area and highly dehydrated employees are being communicated instantly to visit the medical center or an ambulance will be sent for immediate

action, see Table 2 for protocol. The objective of the hydration level monitoring is to encourage employees to come to work fully hydrated and maintain hydration during their shift. The samples collected and analyzed showed better compliance to the programme compared to the previous year due to the awareness and area ownership of the programme.

Table 2. EGA protocol for hydration level of employees working in high heat stress areas.

Hydration Level	Specific Gravity	Required Actions
Hydrated	<1.015	Maintain fluid intake
Mildly Dehydrated	1.015 to 1.024	Send SMS to employee and SMS/email to employee's supervisor advising to increase fluid intake
Moderately dehydrated	1.025 to 1.030	SMS sent to employee, supervisor and safety specialist advising that the employee must take a rest in a cool area for 1h and drink 1L of water
Highly Dehydrated	>1.030	SMS sent to employee, supervisor, area superintendent and safety specialist advising the employee to attend clinic Employee to be seen by the doctor in the clinic for investigation and treatment Employee released back to duty as per doctor's discretion and after counseling.

2.5 Administrative Control

The OHH and the safety team work hand in hand to ensure the safety and health of the employees during summer months. Shifts usually start with a Tool-Box Talk (TBT) emphasizing the importance of drinking water and reporting any early signs of HRI. A one-page lesson can be also discussed during the TBT which was already communicated by the OHH team. Walkabouts are conducted regularly to check the employees' health during summer months and ensure they are following all prevention tips and recommendations presented during training and other visual aids. On the other hand, area management is taking ownership in preventing HRI by fulfilling the requirements and provision of extra manpower where needed during summer months.

EGA has also considered Thermal Work Limit (TWL) approach which Abu Dhabi Occupational Safety and Health (OSHAD) has introduced, as it will give specific assessment and categorized employees in different age groups, calories burn based on the intensity of activity and WBGT reading. This will enhance and support EGA existing BTH program to have more elaborative and comprehensive program to prevent HRI.

2.6 Engineering Control

Welfare facilities inspections are carried out to ensure the efficiency of all amenities and services available for employees. Washrooms, shower areas, chillers, changing rooms and mess halls shall meet the requirements and be ready for use in summer and in case of malfunction this is notified to the area management for action. To ensure water quality we do analyze it regularly to check the quality of the water dispensers, fountains, and ice machines; if any detection of bacterial growth is notified, required action is taken. In addition to that, recovery areas such as the cooling booths are available near hot works and well maintained with air conditioning and a water dispenser for employee's rest.

As a new initiative introduced in operation, fans were installed in front of recovery areas as precooling stage. This initiative is a pilot trial based on the effectiveness and support in cooling during summer season. We have initiated provision of new fans in all potlines. This initiative helped employees to cool down when working outdoors which therefore reduced the risk of developing HRI.

2.7 Fatigue and Overtime Management

As part of heat stress training, we recommend that employees rest for a minimum of 8 h before their shift. To ensure the smooth implementation of this recommendation, a fatigue management policy related to work hours and overtime, was set at EGA as mandatory. The policy assured management of fatigue appropriately by providing adequate rest and managing total working hours more effectively.

The policy emphasizes normal maximum 12 working hours, including overtime. Exceptionally, during unplanned critical contingency, the working hours per day can be extended up to 16 hours after performing a fatigue assessment. This assessment must be done by the supervisor to evaluate the employee's ability to continue working and agree on carrying on the task assigned. The supervisor is responsible to define the necessary measures to reduce the probability of incident or illness. Minimum restorative rest period between 2 consecutive shifts is 10 hours; in case that this cannot be met, the area should arrange necessary resting rooms and welfare facilities with full board package for the employee on his working site.

In case of supervisor absence, an assessment is conducted and documented by the person in charge of the area after 12 hours of continuous work to manage fatigue risks before work can continue up to a maximum of 16 hours. Individuals are encouraged to self-assess when they believe they may be impaired due to the effects of fatigue, and to evaluate their fatigue level before starting their shift. This assessment is voluntary.

2.8 Physiological Assessment for Heat Exposure Monitoring

As part of HRI prevention programme, dedicated nurses conduct walkabouts, to check oral temperature, make random hydration level tests, and measure recovery heart rate and blood pressure. Besides interactions with the shift, one-to-one awareness sessions and counseling are also given. Interventions are taken in case there are signs or symptoms of heat stress observed on the employee.

A scientific group from World Health Organization (WHO) recommended two physiological limits for exposure to industrial heat stress [7]: Core body temperature and recovery heart rate. The core body temperature shall not exceed 38 °C for prolonged daily exposure to heavy work.

It is advisable to use available technologies to continuously monitor heart rate according to reference [8]. At EGA, a new pilot trial initiative was proposed recently to assess employees' physiological parameters during their three working shift patterns by the wearable digital devices. Fifty volunteers working in EGA's potlines, which are amongst the hottest parts of the company's operations, are wearing devices to monitor critical health indicators including core body temperature, heart rate, sweating rate, activity levels, and motion metrics. Data is transmitted in real time to supervisors and EGA's occupational health team, with alerts to variations of potential concern. Use of the technology is expected to further improve timely detection of the earliest signs of heat-related illness and speed of intervention. The trials will last until the end of the summer. The results will determine the way forward. Indications are that wearable technology offers the prospect of zero heat related health cases every summer.

3. Conclusions

EGA has decades of experience in protection workers from heat stress and heat related illnesses. EGA has developed world-class best practices to ensure worker safety in hot conditions. EGA's heat stress prevention programme 'Beat the Heat' includes training and awareness, provision of appropriate facilities for cooling down and hydrating, health monitoring, and many other controls. Due to early reporting and intervention, all reported heat related cases were quickly and effectively managed by EGA Medical Services with first aid treatment. EGA's goal is zero heat related illness cases.

EGA's 'Beat the Heat' programme is an intense, annual summer-long effort across operations, which starts with awareness programmes to build knowledge of heat-related illness and its early signs for individuals and those around them.

4. References

1. World Meteorological Organization (WMO), 2016 WMO Statement on the state of the global climate of WHO No-1189, https://library.wmo.int/opac/doc_num.php?explnum_id=3414 (accessed on 15 July 2022).
2. B.D. Dinman et.al., Work in hot environment: I. Field studies of work load, thermal stress and physiologic response, *Journal of Occupational Medicine* 16, 1974, 785-791, DOI: 10.1097/00043764-197412000-00005).
3. Thomas E. Bernard, Ronald R. Cross, Case study heat stress management: case study in an aluminum smelter, *International Journal of Industrial Ergonomics* 23, 1999, 609-620.
1. Bich Dang, Chad H. Dowell, Charles Mueller, MS., Heat stress and strain evaluation among aluminum potroom employees - Texas, *NIOSH Health Hazard Evaluation Report HETA* 2006-0307-3139, August 2011.
2. , Adaptation of UAE's public health to climate change, *MOCCAE, Ministry of Climate Change and Environment,* 2019*.'*
3. James C. Wesdock, A. Michaem Donoghue, Life-threathing heat-related illness with severe hyponotermia in an aluminum smelter worker. *Am J Ind Med*, 62, 2019, 1068-1075.
4. World Health Organization, WHO: Health factors Involved in working under conditions of heat stress, Technical Report Series 412, Geneva, Switzerland, 1969.
5. D.P Humen, D. R. Boughner, Evaluation of commercially available heart rate monitors *Can.Med.Assoc.J.* 131, 1984, 585-589.