Aggregate Plant Redesign

A Major Qualifying Report

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Abstract

This project, sponsored by Worcester Polytechnic Institute and P.J. Keating Company, has been prepared for P.J. Keating Company and provides a site evaluation for the aggregate and asphalt plant located in Lunenburg, MA. Through the completion of situational analyses of specific aspects of the plant, recommendations are proposed in an effort to better match plant production with customer demand. The managerial impacts of the proposed recommendations were also considered in the completion of this project.

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1.0 Introduction

Aggregate stone plants and quarries are crucial economic entities that provide the raw materials needed for the construction industry. As with any industry, the aggregate industry is largely driven by the relationship between supply and demand. These levels of supply are driven by a consumer's wants and needs for products that require the use of natural materials. A supplier's ability to extract reserve stone through quarrying and process it at an efficient rate is what makes it possible for them to meet demand. As such, it is important that a stone plant and quarry operate as efficiently and effectively as possible in order for a company to maximize its output and profit.

Founded in 1923, P.J. Keating Company is a leading manufacturer of construction earth products in the Northeast[1]. Presently, P.J. Keating has facilities located in Lunenburg, Acushnet, and Dracut Massachusetts, as well as Cranston, Rhode Island. These facilities provide customers throughout the Northeast with aggregate quarrying, crushing, and Hot Mix Asphalt (HMA) services. The Lunenburg facility in particular works to service the customer base located in Central Massachusetts, MetroWest Boston, and Southern New Hampshire. The facility itself consists of two HMA plants; the first of which is an Astec double-drum type plant, and the second of which is an H&B 5-ton batch-type plant[2]. Together these high-production facilities provide for 1,000-ton HMA storage capacity. In addition to the HMA services, the facility also contains a quarrying and crushing operation that produces both washed and dry dimensional crushed aggregate products. The products produced by the Lunenburg facility can be categorized into three distinct types; asphalt products, stone products, and base, sand, and fill products. These products are further detailed in Appendix A.

Currently, P.J. Keating Company is a subsidiary company of Oldcastle Materials. Oldcastle Materials is the leading vertically integrated supplier of aggregates, asphalt, ready mixed concrete, and construction and paving services in the United States[3]. P.J. Keating Company exists as a daughter company in the Northeast Division of Oldcastle Materials. This division includes the states of Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont. As one of the thirteen Oldcastle-owned companies in the region, P.J. Keating Company has helped to establish the Northeast Division as the largest producer of hot-mix asphalt and aggregates in

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[1] www.pjkeating.com
[2] Ibid
[3] www.oldcastlematerials.com

the New England and New York/New Jersey markets[4]. A list of companies comprising the entire Northeast Division of Oldcastle Materials can be found in Appendix B.

This project concerns itself with the production aspect of the aggregate industry. More specifically, this project concerns itself with P.J. Keating Company's aggregate stone and asphalt plant located in Lunenburg, Massachusetts. Through an overview of the current plant set-up and a situational analysis of production, this project aims to propose recommendations that optimize plant production and better match customer demand.

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[4] Ibid.

2.0 Literature Review

The first two topics discussed in this section give the definition of an aggregate and detail the characteristics that constitute quality aggregate as it relates to this project. These sections are then followed by a description of the aggregate production process, chronicling the drilling and blasting, crushing, sifting, cleaning, and stockpiling phases. Following this process description the definition of Hot Mix Asphalt (HMA) is given and the characteristics of quality HMA are discussed. Next, the HMA production process is discussed. Finally, the current and emerging industry trends are included for the aggregate industry. The organization and substance of this literature review conveys the background information necessary to understand the analysis and redesign of the Lunenburg site.

2.1 Aggregates

2.1.1 What is an Aggregate?

Though the term aggregate has several definitions, the most appropriate for the project is "a collection of crushed or fragmented mineral rocks extracted and produced through mining or quarrying operations[5]." Two of the primary uses for aggregate within the construction industry are for the production of concrete and HMA.   Aggregates bound together with Portland-cement and water form concrete, whereas HMA is created through the bonding of aggregates with tar. Depending on the size and grading of the product used, aggregate generally comprises 93-96% of the paving mixture for HMA with the remaining 4-7% consisting of "liquid" asphalt[6]. Because concrete and asphalt are major components of nearly all construction projects conducted throughout the United States, aggregates constitute an important segment of the industry.

For the purposes of this project, aggregates can be separated into two broad classifications: sand and gravel aggregates, and crushed-rock aggregate. Sand and gravel aggregates are aggregates that occur freely in

Figure 1: Comparison of Sand and Crushed Rock Aggregates

nature. These are often found in deposits created by rivers, ocean beds, or glaciers. These sand and gravel aggregates are gathered by excavating a pit, and often only require screening before immediate use. Crushed-rock aggregate is produced primarily from bedrock reserves, which require the drilling and

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[5] Grolier, 2001: 508
[6] NSSGA, 2003: 1

blasting of quarry faces before they can be obtained. This type of aggregate requires crushing, screening, and in certain cases washing, before use[7].

2.1.2   What Constitutes Quality Aggregate?

Although the characteristics of quality aggregate depend on how the aggregate is being used, suitable aggregate consists of clean, uncoated particles of proper size, shape, gradation, hardness, strength, physical soundness, and chemical properties[8]. The attributes listed below detail the factors that contribute to high quality aggregate.

- Size and consistency: The material used needs to be similar in size and shape in order to avoid compaction problems. This helps to lower the rolling costs of the pavement while increasing quality[9].

- Cubical particle shape: Cubical material allows for better stability while also increasing the workability of the substance. This lowers costs while increasing quality and skid resistance of the pavement[10].

- Low Moisture: Low moisture content lowers the costs associated with drying the aggregate and also increases the material's stripping resistance[11].

- Absorption: The lower the absorption rate, the less aggregate is needed for use in a mixture. This is a significant cost consideration because it allows a company to produce more cubic feet of asphalt per ton of aggregate[12].

- Hardness and strength: The hardness and strength of aggregate dictates the products ability to resist breakdown. Breakdown generally occurs when aggregate is mishandled during the production process or through implementation[13].

Utilization of a quality aggregate in mixtures will provide consistency in the HMA or concrete mix. The end result of this is a more structurally sound and consistent structure.

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[7] West, 1996
[8] Pit&Quarry, 2003
[9] NSSGA, 2003
[10] Ibid.
[11] Ibid.
[12] Ibid.
[13] Pit&Quarry, 2003

2.2   The Production of Aggregate

As previously mentioned, aggregate can be classified into two general categories: crushed-rock and sand/gravel. The production process for each of these classifications is similar with the difference between the two being the degree of gradation. Generally speaking, sand/gravel aggregate is produced to a higher quality because of its construction application purposes. Because the aggregates produced by P.J. Keating Company are used in a variety of mixtures and applications, it is crucial that the proper production stages are carried out. This section discusses the basic production stages of aggregate.

2.2.1   Quarry Assessment

The production of any aggregate begins in the quarry. A quarry is broadly defined as "the depression left on the earth's surface from which construction aggregates have been taken out[14]." For the purposes of this project, the term quarry will refer to an open or surface quarry, which refers to a quarry where "minerals lie near the surface…typically where drilling and blasting are required[15]." The terms "reserve" and "deposit" are often used to describe the natural resources beneath the earth's surface. A reserve refers to the land area with the potential to hold a given amount of a natural resource. A deposit is the portion of a specified reserve that contains the desired resource.

Figure 2: A view of a Quarry

Several factors must be taken into consideration when assessing a quarry's reserve. The first consideration is the amount of quality grade rock that is recoverable from the reserve. If a deposit does not possess the required physical and chemical properties for its intended application, it is not worth mining. In addition to the deposit itself, environmental factors associated with extraction are an important aspect to consider. Major environmental concerns can delay the permitting and extraction processes indefinitely. A final factor to consider for a particular quarry is the ease of extraction. Extraction equipment, transportation equipment, and the proximity to a processing plant are all factors that influence the assessment of a particular site. Failure to properly assess all of

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[14] www.empr.gov
[15] Ibid.

the previously mentioned considerations will result in the failure to maximize the potential of the quarry[16].

2.2.2 Methods of Extraction

Aggregate is a natural resource that must be extracted from the earth's surface through mining or quarrying. Though often used interchangeably, mining refers to the act of digging underground for the desired material whereas quarrying (also called surface mining) is the extraction of minerals directly from the outermost layer of earth's surface[17]. Though different in definition, both processes usually require drilling and blasting, which breaks down the bedrock into a more transportable size.

Once drilling and blasting has been completed, bulldozers, power shovels, front-end loaders, and tractor scrapers are used to load the shot rock into haul trucks. These haul trucks then transport the material to the processing plant by way of a haul road. Because the cost of handling and transporting material is high, it is advantages to locate a processing plant as close to the quarry as possible. An important consideration in the extraction process is whether or not to make processing equipment permanent or portable. Generally this decision is determined by the size of the quarry and the accessibility of the deposits in the reserve. Permanent plants are often employed by quarries with reserves expected to last at least 10 years. In order to understand how long a reserve will last, proper site assessment must be conducted through outcrop observations, and drilling and sampling procedures[18].

2.2.3 Primary and Secondary Crushing

Once the rock has been extracted from the quarry and transported to the processing plant, it is fed into crushing machines. This crushing process can be carried out in multiple stages by primary and secondary crushers, which are designed to break and fragment the shot rock into various predetermined sizes. Depending on the intended use of the aggregate, primary crushers may be the only equipment employed. If a smaller, more uniform-sized aggregate is required, then secondary and tertiary crushers are utilized.

There are four basic types of primary crushers that can be used in an aggregate stone plant: the jaw crusher, gyratory crusher, impact crusher, and the autogenous crusher. These four types of primary crushers are explained in detail below.

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[16] Pit&Quarry, 2003
[17] Bowles, 1934
[18] Dusseault & Franklin, 1991: 8

- Jaw crusher: A jaw crusher fragments material by squeezing it between two surfaces, one of which opens and closes like a jaw. The material enters the crusher from the top and pieces of rock that are larger than the opening at the bottom of the jaw lodge between the two metal plates of the jaw. The opening and closing action of the movable jaw against the fixed jaw continually reduces the size of the lodged pieces of material until they are small enough to fall through the opening at the bottom[19].

- Gyratory crusher: A gyratory crusher fragments material by squeezing it between an eccentrically gyrating spindle and the enclosing concave hopper. The spindle is covered by a wear resistant mantle to reduce wear to the machine. As material enters the top of the crusher, it becomes wedged and squeezed between the mantle and hopper. Large pieces of material are broken once and then fall to a lower position where they are broken again. This process continues until the pieces are small enough to fall through the narrow opening at the bottom of the crusher[20].

- Impact Crusher: Impact crushers, or hammer mills, fragment material by impacting it with hammers that swing on a rotating shaft. The practical use of this type of crusher is limited to softer materials such as phosphate, gypsum, and the like. Although impact crushers cannot handle as large a top sized material as jaw or gyratory crushers, they are able to make a finer sized product[21].

- Autogenous Crusher: Recently, autogenous crushers have been adapted for crushing shot rock in primary crushing circuits. Because of this, autogenous mills have become more important as a means of crushing and grinding. In these crushers, the rock that is being crushed also provides the fragmenting force. This is accomplished by the tumbling action of the material. As the mill rotates the material inside tumbles with it and collides with other material surrounding it. Flexible crushing circuits can be implemented so that hard and soft material can be processed. Another advantage of these types of crushers is that they are able to process wet material better than other alternatives[22].

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[19] www.prlog.org
[20] Ibid.
[21] Ibid.
[22] Ibid.
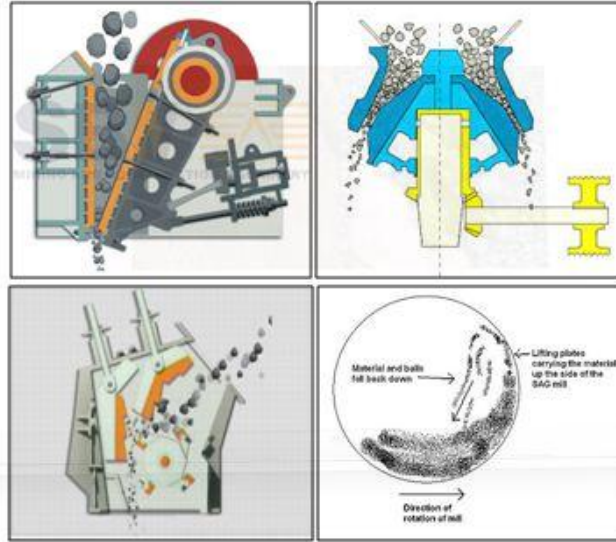
Selecting the proper primary crusher for a plant is essential because they can contribute to significant differences in production. Important factors to consider when selecting a primary crusher include: maximum feed size of the shot rock, product size allowed to be fed to secondary crushers, the production rate required to yield that correct size, the characteristics of the material being processed, and maintenance availability for the crusher itself. The characteristics of the material to be processed that can influence the choice of a primary crusher are the type of mineral, hardness, abrasiveness, moisture content, and the reduction ratio[23]. Once a primary crusher has been chosen, a secondary crusher that is well-suited to the crushed-rock size and output rate of the primary crushing stage can be selected.

2.2.4   Screening Process

Often referred to as the "cash box" of the aggregate plant, the screening process separates the crushed stone by size. Different screening decks corresponding to each crushing stage are used depending on the line of crushers (primary, secondary, tertiary). These screen decks are situated in screening towers and act as large sieves which sift out the stone by size. Each tower is generally fed through the top by a conveyor, with each the openings for each screen deck becoming narrower as the stone flows down the tower. In some cases the screens are equipped with heat-treating, vibrating, and washing/rinsing equipment. The screens themselves can be made from a variety of materials including

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[23] Dusseault & Franklin, 1991.

wire cloth, long-slot wire cloth, perforated plates, profile wire, urethane, or rubber. The choice of screen material is dictated by impact resistance, aggregate abrasiveness, aggregate size, moisture content, noise level tolerances, and the comparative cost to production[24]. Urethane screens perform best with wet and highly abrasive materials, whereas rubber screens are better suited to dry, high-impact conditions. Wire cloth is generally employed in tertiary conditions and high productivity applications. Self-cleaning and long-slot screens are recommended for materials with high moisture content in order to better avoid clogging effects such as plugging or blinding[25].

Figure 4: A Screen Tower

2.2.5   Washing/Scrubbing

The final production stage of the aggregate cycle is the washing/scrubbing stage. In this stage coarse and fine material washers, screw washers, and spray washers are used, depending on the type of aggregate. The main purpose of this washing stage is remove impurities from the finished product. These impurities are primarily the result of dust produced from the crushing stage, but can also include foreign matter transported from other stages in the process. Determining the proper washing mechanism relies heavily on two factors: the amount of available water and the type of impurity being removed[26]. A screw washer is designated for sand production because the incorporated spiral effect forces the sand particles against each other, thus washing away impurities. The process is gentle enough to retain the fine sand particles, while still removing impurities. Material washers are generally used for gravel ranging from 1/8" to 3" in size. These washers consist of paddles welded inside a large drum which rotates as the material is wet-down. In most other wash applications, a spray washer (or bar) is used to wet-down the aggregate as it travels along a conveyor[27].

2.3   The Environmental Impacts of Aggregate Production

From the extraction of material to the use of processing equipment, there are many technical factors involved in aggregate production. Although many consider aggregate production a purely physical process, there are many underlying factors that must be taken into consideration if a company

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[24] Dusseault & Franklin, 1991.
[25] Pit&Quarry, 2003
[26] Day & Nichols, 1999
[27] Pit&Quarry, 2003

hopes to remain successful. Included in these underlying factors are environmental and societal implications that must be addressed throughout the production cycle. This section will highlight the most common of these environmental and social considerations that arise throughout the process.

2.3.1   Environmental Impacts

Historically, the environmental impacts of the aggregate industry have been an area of contention between the quarry industry and environmental officials. This area of contention often occurs because quarry owners believe their operations have minor environmental effects, while environmentalists claim the effects are much more significant. Because stone and other natural construction materials are generally extracted from shallow or naturally exposed deposits with the use of little to no processing equipment, the environmental impacts are limited to land disturbance at the quarry and the waste generated by the process[28].

Many government officials and environmentalists believe that the process of industrial mineral extraction has significant long-term effects that are overlooked or unidentified at the outset of operations. This issue was recently discussed at the 2002 World Summit, where concerns regarding the increased consumption of natural resources, sedimentation of waters, and destruction of forests were addressed. The national governments, United Nations agencies, development workers, and lawmakers that attended this summit brought forth concerns that many of these issues were in part the result of increased quarry operations[29]. However, the majority of the damage caused by the extraction of these natural resources is often considered a local problem and is justified as an unavoidable cost to economic development[30]. Regardless of how these impacts are portrayed, it is important to consider that the mining of construction materials can lead to problems such as surface disturbance, soil erosion, air pollution, particulate emissions, and the disruption of drainage systems[31]. Furthermore, the drilling and blasting operations needed to develop these sites can also produce noise and shock complaints from neighboring communities.

2.3.2   Surface Disturbance

Before quarrying activities can begin the top soil and vegetation (often referred to as overburden) are removed from the site. This overburden removal itself often presents environmental concerns for the company as. Because the process itself results in the deforestation of a particular area,

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[28] Young, 1992: 18
[29] Worldwatch Institute, 2002
[30] Young, 1992
[31] Ripley, 1996

the destruction of natural habitats and the migration of its inhabitants must be considered. In addition, the regulations and procedures put in place by local and national governments must be navigated before the process can begin. These regulations are often established for the protection of local wildlife which, due to quarry operations, can be forced to seek refuge in surrounding urban areas thus creating potential safety hazards and concerns[32].

2.3.3 Soil Erosion

The issue of soil erosion is also largely a result of the overburden removal process. As natural vegetation is removed from the area, the sediment contained there is loosened and can run-off into natural water sources. This run-off is particularly troublesome near coastal areas. Though coastal

Figure 5: Soil Erosion in a Quarry

erosion occurs naturally through tidal movements and powerful wind and waves, sand and gravel mining can expedite this process. While it is estimated that natural erosion results in the loss of 0.3m to 1.5m of coastline each year, a sand and gravel mines can further deplete the shoreline by 150,000m^3 per year[33]. While erosion of this extent is largely limited to developing island nations where the material is used in the development of shoreline communities, it is important to understand the impact these operations can have on the environment.

2.3.4 Air Pollution

The main airborne pollutants caused by aggregate production are dust particulates. These atmospheric emissions can be released into the environment by a variety of activities including drilling, blasting, crushing, conveying, stockpiling, vehicle traffic, and through natural conditions like strong winds. In extreme cases these particulates can act as carriers or toxic materials emitted from mining equipment[34]. In aggregate plant and quarry operations, particulate matter less than 10 microns in diameter is considered respirable dust and is a health concern[35]. In addition to affecting human health, these dust particles can also interfere with the photosynthesis process of local vegetation if not managed properly.

One major health concern that must be taken into account by any aggregate operation is the emission of silica dusts. Silica occurs naturally as quartz in sands and gravels. High levels of silica, or

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[32] Sengupta, 1993
[33] Borges, Andrade, Freitas, 2002
[34] WSDE, 2001
[35] MSHA, 2006

long term exposure to silica dust, can lead to a health condition known as silicosis. Silicosis is a respiratory disease caused by the inhalation of crystalline silica which results in the inflammation of lung tissue[36]. Over time this tissue becomes scarred, thus obstructing the flow of oxygen into the lungs and bloodstream. Because the emission of these dust particulates can have severe health concerns, it is important for any company to continuously monitor the dust produced by their operations, and to provide their employees with the proper equipment and knowledge to promote their safety.

2.3.5   Water Quality

Water is the most basic medium used to control dust problems in the aggregate production process. This is done through the wetting of production machinery and the saturation of stockpiles in order to limit particulate emissions. In most industrial material excavations, the wastewater produced by these processes is the greatest environmental concern. Sand, gravel, and dimensional stone are generally chemically inert and therefore do not usually present a risk to drinking water, however the sediments and chemicals used in quarry operation can have a negative effect on the local water supply[37].

In sand and gravel operations it is estimated that two tons of water are used for each ton of sand or gravel produced. However in larger stone aggregate operations, this use is significantly less. Runoff wastewater from these operations often contains suspended particles of sand, silt, or clay which can account for 1% to 20% of the liquid. This sediment can then be carried into streams, lakes, ponds, or wetlands where it changes the natural composition of the system. These run-off sediments have been found to have negative effects on benthic communities, plankton, and the reproductive capabilities/structure of fish and plant populations in these ecosystems[38]. Wastewater that runs into nearby water sources increases the cloudiness (turbidity) of the water thus reducing light penetration. This in turn impairs the respiration of fish and other aquatic wildlife while also limiting the ability for aquatic vegetation to survive. The added nutrients contained in the wastewater can also result in surface algal scum and unpleasant odors[39].

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[36] Ripley, 1996
[37] Hutchinson, Ellison, 1992
[38] Ripley, 1996
[39] ASLA, 2002

2.4   Hot Mix Asphalt

2.4.1   What is Hot Mix Asphalt?

Hot mix asphalt, also known as asphalt concrete, refers to the bound layers of a flexible pavement structure[40]. In most applications, HMA exists as a mixture of coarse and fine aggregates as well as asphalt binder. The mixture is placed and compacted at elevated temperatures, hence its name. While asphalt concretes can also be placed at ambient air temperatures, elevated temperatures increase the workability of the mix and make it easier to use. Because of this, HMA is the primary placement method for large applications such as roads and interstates.

During the construction of these roads and interstates HMA is typically applied in 4"-8" thick layers. The lower layers of the mix act to support the top layer, known as the surface or friction course[41]. Each layer of the HMA mix is designed for its intended application. The aggregates for the lower layers are selected to prevent rutting and failure, while the aggregates of the top layers are chosen for their friction and durability properties. Because HMA relies heavily on the aggregate used in the mixture, it is important to select the proper materials for the mix design.

2.4.2   Hot Mix Asphalt Mix Design

Mix design is broadly defined as the selection of suitable materials for a mixture such that their relative properties produce a product with the desired characteristics for a particular application. For HMA applications, this mix design concerns itself largely with the selection of aggregates and asphalt binder. The selection of these materials dictates the performance of the HMA. A list of common performance concerns in HMA mix design is shown below:

- Resistance to Permanent Deformation: A successful HMA mix will not distort or displace under traffic loading. This deformation often occurs during high temperatures which soften the asphalt binder and place the load predominantly on the aggregate structure. Resistance to permanent deformation can be controlled through improved aggregate properties, proper gradation, and proper asphalt grade and content[42].
- Resistance to Fatigue and Reflective Cracking: Fatigue and reflective cracking resistance is inversely related to the stiffness of a mix. Although stiffer mixes increase rut resistance, designing a mix for rut resistance alone is detrimental to the overall performance of the HMA.

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[40] www.industrialresourcescouncil.org
[41] Ibid.
[42] Roberts, et al. 1996

Fatigue and reflective cracking can be prevented by striking a better balance between rut and crack resistance design. This is done primarily through the proper selection of the asphalt binder[43].

- Resistance to Low Temperature (Thermal) Cracking: Thermal cracking occurs when low temperatures freeze the water contained within the HMA. As the water freezes, it expands, causing cracks in the surface of the pavement. This thermal cracking can be mitigated by selecting asphalt binder specifically designed for low temperature applications[44].

- Durability: A properly designed HMA mix will contain enough asphalt cement so that and adequate film thickness exists around the aggregate particles. This film helps minimize the hardening and aging of the asphalt binder during production and while in use. Sufficient asphalt binder content also ensures adequate compaction of the mix while in the field, while also limiting air voids[45].

- Resistance to Moisture Damage (Stripping): Stripping occurs when a loss of adhesion occurs between the aggregate surface and the asphalt binder. The assumption of the mix designer should be that moisture will eventually penetrate the pavement structure; therefore mixtures in all levels of the pavement structure should be designed with anti-stripping agents[46].

- Workability: Mixes that are easily compacted in laboratory settings may not be as easy to compact in field applications. Adjustments must be made in the mix design to ensure that the mix can be properly placed in the field without sacrificing performance. The workability of a mix is largely controlled by its temperature and moisture content. Higher temperatures and moisture contents result in a mix that is more fluid, and thus easier to place[47].

- Skid Resistance: Skid resistance is an important consideration for surface mixtures that must have a sufficient resistance to skidding, particularly under wet weather conditions. Aggregate properties such as texture, size, shape, and resistance to polish all contribute to the skid resistance of a mix. Aggregates for mix designs with a high skid resistance are selected largely based on their frictional and durability properties[48].

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[43] Ibid.
[44] Ibid.
[45] Ibid.
[46] Ibid.
[47] Ibid.
[48] Ibid.

By identifying the necessary properties for the application of a specific mix, the HMA materials can be properly selected in the design process. A properly designed mix is crucial in producing a product that is effective and durable.

2.5 Industry Analysis

2.5.1 Industry Definition

The asphalt paving industry is the industry segment responsible for many of the world's motorways, highways, streets, airport runways, parking areas, driveways, coastal protection areas, canal linings, reservoirs, footpaths, cycle paths, and sport and play areas[49]. Asphalt plays a vital role in global transportation infrastructure and drives economic growth and social well-being in developed and developing countries[50]. Because of the importance of this infrastructure and the need to ensure the quality and durability of the paved facilities, the industry must provide materials and apply production methods which result in an end-product acceptable according to the high standards set by owner agencies.

2.5.2 Current Industry Assessment

Public investment in highway, street, and bridge construction in the United States totals around $80 billion per year[51]. It is worth noting that these numbers do not include private-sector investments in streets, parking facilities, or commercial and residential facilities, making the industry even larger. North America itself has one of the largest and most extensive networks of paved roads and highways in the world. In the United States alone it is estimated that more than 92% of the 2.5 million miles of roads and highways are surfaced with asphalt[52]. Furthermore, about 85% of airport runways and 85% of parking areas in the US are surfaced with asphalt as well[53]. In short, this means that the demand for asphalt is continuous and steady.

As we would expect, production of asphalt has matched the demand for the product. In 2007, the last year for which figures are available, the North America produced 550 million metric tons of asphalt, by far more than any other region of the world[54]. The production of this asphalt directly

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[49] The Asphalt Paving Industry A Global Perspective
[50] Mangum, 2006
[51] The Asphalt Paving Industry A Global Perspective
[52] Mangum, 2006
[53] Ibid.
[54] Ibid.

employed 14, 923 workers, and a further 400,000 in related industries[55]. These employment numbers indicate that the asphalt industry is an important part of the American economy, especially since it constitutes jobs that cannot be outsourced overseas.

It is worth noting, however, that these employment statistics do not reflect the economic downturn that began in 2007. As previously mentioned, the asphalt paving industry relies heavily on public funding, and as a result it has been particularly hard hit by the down economy. In fact, unemployment for workers in this industry is at twice the national rate[56]. With most of these workers unionized, many of the young entrants into this field find themselves without jobs. This is particularly important because it has created an age gap within the industry. As the current workforce nears retirement age, there are few individuals with enough experience to take their place. As such it is crucial for any facility to work to give their younger workers as much experience as possible.

2.5.3   Emerging Trends

As is the case with many construction sub-industries, the emerging trends in the aggregate industry has largely been centered on creating a more sustainable business practice. As natural material resources are used and exhausted, it is in the best interest of the industry to promote new and innovate ways at producing product, while also working to minimize cost. This is particularly true of the Hot Mix Asphalt field, where industry costs rely heavily on oil prices. As the price of oil has risen over the past decade, aggregate companies have sought alternate sources of oil and material.

Figure 6: Asphalt Shingles

The high cost of oil has led to the recent trend of using recycled asphalt shingles (RAS) in asphalt mixes. Because RAS contain up to 5% liquid asphalt[57], and because they are so readily available in the construction industry, they have become a popular supplement to virgin oil in HMA mixtures. Through the shingle recycling process, the shingles are separated from other construction debris before being ground down by an asphalt shingle grinder. These ground shingles are then used as an additive in HMA mixtures, partially substituting for virgin oil and fine aggregates. This use of recycled shingle product lowers the production cost of HMA and allows for a larger profit margin for companies. Furthermore,

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[55] Asphalt Paving Association of Oregon
[56] Ibid.
[57] Ibid.

because aggregate and asphalt plants often provide a more convenient and lenient alternative to landfills, the shingles are dropped off by contractors free of charge. This means that a company must only incur the cost of processing the shingles, either by hiring a sub-contractor or purchasing the processing equipment.

In a similar manner, many companies have been expanding their use of recycled asphalt pavement (RAP) as well. RAP is produced when the old pavement is milled from a roadway prior to being repaved. This milled pavement also contains usable liquid asphalt and aggregate stone. The availability of this product as a regular part of the paving process has led many companies to process and reuse it, instead of hauling it to landfills. With over 95% of companies using RAP in some capacity in their mixtures[58], it has become an important part of the modern industry.

Because the emerging trends within the aggregate industry focus largely on the use of recycled products and the more sustainable use of natural resources, it is in the best interest of individual companies to take advantage of them. Not only do these trends allow production costs to be lowered, but they also portray the industry in an environmentally friendly light. This portrayal goes a long way in promoting good relationships within the local community, as well as allowing the industry to continue to grow and adapt to the changing business environment.

2.6   P.J. Keating Company Structure

2.6.1   Corporate Structure

Founded in 1978, Oldcastle, Inc. is the North American subsidiary of the Ireland-based building materials company CRH plc. Oldcastle itself is divided into two organizational units; Oldcastle Products and Distribution (OPD) and Oldcastle Materials[59]. The OPD division includes Oldcastle Glass, Oldcastle Architectural Products, Oldcastle Distribution, Oldcastle Precast, and Oldcastle Merchants Metals. All of these companies supply materials and services for the construction of buildings within North America. The second organizational unit of Oldcastle, Oldcastle Materials, supplies aggregates, asphalt, ready-mix concrete, and paving services for transportation projects across North America. Since its acquisition by Oldcastle, P.J. Keating Co. has existed as a subsidiary of Oldcastle Materials.

Currently, Oldcastle Materials, Inc. is the largest building materials company in North America. The company operates in 50 US states, 4 Canadian provinces, and South America, while employing over

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[58] Ibid.
[59] www.oldcastle.com

40,000 individuals. Within the United States, Oldcastle Materials is divided into seven operating divisions: the Northwest, Mountain West, Central West, Central, Southeast, Mid-Atlantic, and Northeast[60]. Spanning the states of Maine, New Hampshire, Vermont, Massachusetts, Connecticut, Rhode Island, New York, and New Jersey, the Northeast Division is the largest producer of hot-mix asphalt and aggregates in New England and the New York/New Jersey markets. As one of the leading companies within the Northeast Division, P.J. Keating Co. plays an important role in the success and failure of Oldcastle Materials.

2.6.2   Internal Structure

Presently, P.J. Keating has facilities located in Lunenburg, Acushnet, and Dracut Massachusetts, as well as Cranston, Rhode Island. The Lunenburg plant serves as the company's flagship facility and services customers across the greater Boston area. The production side of the plant is overseen by the operations manager Kevin Younkin. He works in coordination with the plant manager, Ryan Gagliano, and the asphalt manager, Scott Highly to produce product and service customers. Ryan and Scott both manage and oversee a team of foremen and laborers who operate their respective plants. These laborers and foremen are all members of the International Union of Operating Engineers Local 4. The other P.J. Keating plants follow a similar internal structure.
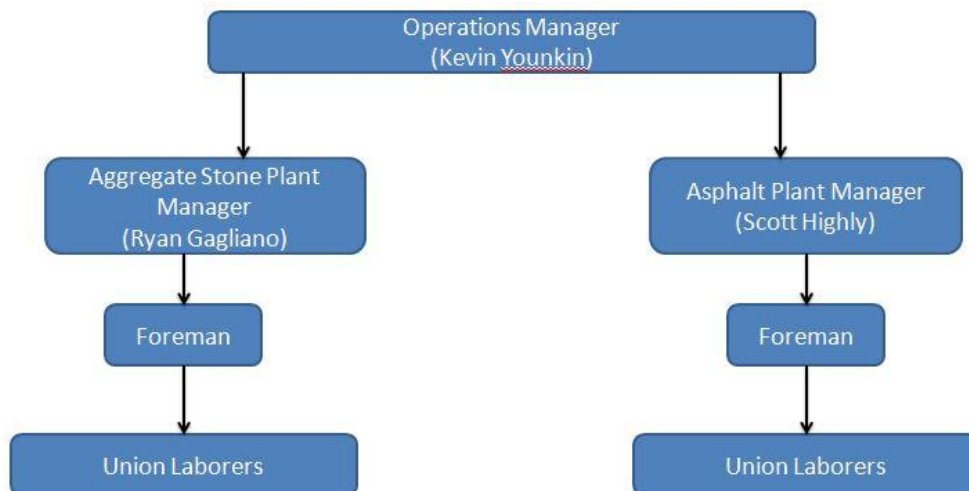
Figure 7: Flow Chart of the Lunenburg Plant Structure

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[60] www.oldcastlematerials.com

Though much smaller than the flagship plant, the facility located in Dracut, MA works in coordination with the Lunenburg plant to service the same customer base. P.J. Keating Co. operates a Cedarapids 6-ton batch-type Hot Mix Asphalt (HMA) plant at this location as well. In addition to this HMA production facility, Dracut has 400 tons of HMA storage capability facilitating service to their customers and mainline paving crews. In addition to the HMA services, quarrying and crushing operation at the Dracut facility produce dry dimensional aggregate products similar to those in Lunenburg[61].

In a manner similar to the Lunenburg and Dracut facilities, the Acushnet, MA and Cranston, RI facilities work in conjunction to service customers located in Southeastern MA, Cape Cod, and Rhode Island. In Acushnet, P.J. Keating Company operates an Astec 500TPH double drum HMA plant. Coupled with this high-production HMA plant is the capability to store up to 2,000 tons of HMA which can be loaded out over two truck scales. The quarrying and crushing operation at Acushnet produces specific-sized dry and washed crushed aggregate products. Additionally, this location is home to three HMA mainline pavement installation crews[62]. Cranston, the smaller of the two plants, has a quarrying and crushing operation that produces both washed and dry dimensional crushed aggregate products. The HMA plant at Cranston is a Madsen 3-ton batch-type plant and focuses on the supply of HMA to the FOB plant material pick up customers exclusively[63].

2.7   Lean and 5S

2.7.1   What is Lean Production?

The process of lean production, or lean manufacturing, has long been a concern for manufacturing companies throughout the world. Simply stated, the idea behind lean production is to maximize customer value while minimizing waste[64]. The ultimate goal behind lean production is to provide perfect value for the customer through a perfect value creation process that has zero waste. To accomplish this, lean thinking shifts the managerial focus from the optimization of separate technologies, assets, and vertical departments to the optimization of the flow of products and services through entire value streams that flow horizontally across technologies, assets, and departments to customers.

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[61] Ibid
[62] Ibid
[63] Ibid
[64] www.lean.org

The ideas behind lean production are often credited to Eli Whitney, the founding father behind the idea of interchangeable parts. The idea later evolved under Henry Ford and his assembly line, and further with the introduction of Just-In-Time production. However, the term "lean" was first applied to the Toyota Production Systems in the late 1980s, and since that time the Toyota Company has been a leader in lean manufacturing[65].

With the main idea behind lean being eliminating waste, it is important to understand how to quantify waste in an industrial sense. With respect to manufacturing waste can take a variety of forms including materials, time, inventory, and idle equipment. Research has shown that most companies waste 70%-90% of their available resources, with even the best lean manufacturers wasting around 30%[66]. Companies that are able to reduce inventories, assets, overhead, wait times, and out-of-specs, will generally increase profit. Simply stated, lean manufacturing is a key contributor for a company being able to consistently outpace competitors across economic cycles, industry cycles, and generations of leadership[67].

2.7.2   Lean Production in the Aggregate Industry

Waste within the aggregate industry has always been a concern for manufacturers because any waste material translates directly into lost sale potential. Because of this, many aggregate plants are designed with features to help mitigate waste material throughout the process. These features often include spray bars to mitigate dust, covered conveyors, and transfer boxes between conveyors to minimize spillage. While these tangible features have been in place for many years, the industry is just now beginning to fully implement the ideologies behind lean production.

The recent economic downturn has resulted in many aggregate plants working to re-examine their production processes in search of ways to minimize waste, and thus increase profit. This has become particularly evident when we examine the increase in six-week lookaheads (SWLAs), Weekly Work Plans (WWPs), Percent Plan Complete (PPC), and Daily Huddle Meetings (or Tool-box Meetings) within the industry.

SWLAs are planning tools that help prepare plants for future tasks. In previous times, aggregate plants had worked to continuously produce stone and then sell based off inventory levels. Recently this trend has reversed, and SWLAs have been implemented to project sales in advance so that production could be coordinated. Though lookahead windows can range anywhere from 3 to 12 weeks, this

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[65] Ibid.
[66] Strategos Inc., 2006
[67] Russell, 2006

advanced planning helps to institute a system that better reflects the needs of the market and customers[68]. By working to match production to customer demand, plants can minimize labor and inventory costs.

Weekly Work Plans are based on SWLAs, the actual schedule, and field conditions. Through the WWP manpower for each trade can be adjusted to meet the need. Typically presented at the beginning of the week, the WWP helps do guide the workforce and covers the weekly schedule, safety issues, quality issues, material needs, manpower, construction methods, backlog of ready work, and any problems that may occur in the field[69]. The process also improves communication throughout a company and can help improve safety, quality, work flow, material flow, productivity, and the relationship among team members.

Percent Plan Complete values are often used as a metric for evaluating the effectiveness of SWLAs and WWPs. The PPC is calculated as the number of activities completed as planned, divided by the total number of planned activities[70]. Although these values are highly variable, usually ranging from 30% to 70% without lean implementation, they serve as a good indicator of plant and planning efficiency.

Daily Huddle Meetings, or Tool-box Meetings, serve as a final planning tool in the implementation of the lean process within the aggregate industry. The main purpose of tool-box meetings is to bring awareness to projects and problem solving, while working to increase employee satisfaction. These meetings generally occur at the beginning of each day and allow each employee to give an update on what they have been working on since the previous day's meeting. They also allow employees to bring up any issues they've had in completing their tasks, and allow management to gather employee-generated feedback. These meetings fall in line with the lean manufacturing concept of employee involvement, which ensures rapid response to problems through continuous open communication with the workforce[71].

2.7.3   What is 5S?

The 5S methodology has its roots in the Japanese examination of the lean manufacturing process. The name is derived from the five Japanese words *seiri, seiton, seiso, seiketsu,* and *shitsuke* which are roughly translated as sorting, straightening, shining, standardizing, and sustaining. The 5S

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[68] Lean Construction Journal, 2005
[69] Ibid.
[70] Ibid.
[71] Ibid.

methodology is implemented in order to organize a workplace for efficiency and effectiveness by identifying and storing the items used, maintaining the area and items, and sustaining that new order.

In accordance with the lean process, the first "S", sorting, eliminates all unnecessary tools, parts, and instructions from an area. Only essential items are kept, and they are prioritized based on need. The "straightening" step requires the ordering of these tools so that the most used ones are the most easily accessible and the easiest to locate. The goal of this step is to eliminate time wasted in obtaining the necessary items for a particular task. The third "S", "shining", refers to the keeping a clean and tidy workspace. Ensuring that workplaces are maintained helps them to retain their neatness, and eliminates wasted time. The "standardizing" step requires that all workstations for a particular job be identical. This ensures that all employees doing the same job can transition easily between stations, and allows for flexibility within the system. The final step is "sustaining" which maintains and reviews standards. By focusing on sustaining the new process, new areas for improvement can be identified and new standards implemented[72].

The most important aspect of the 5S approach is that it helps to establish the lean culture within a specific manufacturing process. By helping employees to change their work mindset, 5S is better able to gear a company toward the lean goals of minimizing waste and maximizing customer value. Furthermore, 5S helps to identify areas of future improvement that the lean methodology is based upon.

2.7.4   5S in the Aggregate Industry

The 5S system is particularly important within the aggregate industry as corporations seek to create a more visual workplace for employees. As with any 5S system that is implemented, the goal for 5S within the aggregate industry is to ensure an organized workplace for employees and to minimize time wasted looking for resources. In most aggregate facilities, maintenance is conducted continuously throughout the day, making the organization of tools and replacement parts crucial. Ensuring that these items are organized not only streamlines the maintenance of the plant, but also allows for an easier transition between work shifts.

Another important consideration within the aggregate industry is safety. Because of this, safety is often incorporated as the sixth "S" in the 5S process. By maintaining organized and clean workplaces, managers can ensure employee safety as well. Because stations within an aggregate plant often include

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[72] Lean and Environment Training Modules, US Gov. 2012

potentially dangerous tools and materials, it is essential that they be maintained in order to prevent injury.

3.0   Methodology

3.1   Current Plant Flow

The current plant flow at the Lunenburg facility can be broken down into seven basic stages: drilling and blasting, the load-haul cycle, primary crushing, secondary crushing, conveying and stockpiling, HMA production, and finally plant maintenance. Through these seven basic stages, the facility is able to produce and maintain all of the products it distributes to its customer base. These stages are described in depth in the following sections.

3.1.1   Drilling and Blasting

The quarry assessment at the plant is conducted by P.J. Keating Co. through the services of Maine Drilling & Blasting. Maine Drilling & Blasting is New England based company that works to provide drilling and blasting services to area clients. Their partnership with P.J. Keating Co. in particular centers on the strategic blasting of stone quarries. Because the Lunenburg site blasts weekly in the quarry, it is important to have a strategic plan in place for the order, size, and layout of each shot.

A second consideration in the quarry assessment is the type of stone being blasted. Because the Lunenburg quarry has multiple types of stone deposits within the site, it is important to understand how these types react to drilling and blasting as well as the crushing process. Generally speaking, it is more advantageous for a company to spend more money in the drilling and blasting phase for harder stone. This minimizes the shot rock size, and puts less strain on the primary crusher and hammer.

3.1.2   Load-Haul Cycle

Figure 8: CAT 777 Haul Truck

After drilling and blasting, the next phase of production is the load-haul cycle. During this stage, the shot rock from the quarry is loaded into haul trucks and brought to the processing plant. Presently, the shot rock is loaded by a single CAT 992 front end loader into CAT 777 haul trucks. In total there are three CAT 777s in the Lunenburg fleet, and they cycle continuously between the quarry and primary crusher. After being loaded in the quarry, the777s travel approximately one mile down the haul road. As they approach the primary crusher, they first stop at a wash station, where water is sprayed into the bed of the truck to wet the material. This wetting prevents dust and particulates from entering the air during the crushing phase. After wetting down the haul truck then

backs up to the primary crusher box where it dumps its load before traveling back to the quarry. Due to the size of the bed of the CAT 777s in comparison with the primary crusher box, each dump occurs in two stages: half of the load is dumped and processed before the second half is dumped and the driver leaves.

3.1.3 Primary Crushing

Primary crushing is the first stage in the processing side of the plant. Crushing begins when the CAT 777s have dumped the shot rock into the primary box. The box is constructed around a 42-65 gyratory crusher which can process over 700 tons per hour. As the shot rock slides to the bottom of the box, it enters the head of the crusher, where a rotating weight slowly crushes it down to size.

Figure 9: A 42-65 Gyratory Crusher

Once the rock has been processed to the proper size, it falls out of the bottom of the crusher, and a conveyor belt carries it to the surge pile.

3.1.4 Secondary Crushing

Once on the surge pile, the crushed stone is transferred to secondary crushers by way of a conveyor belt. After each crushing stage the stone is screened and separated by size. Depending on the desired size of the product, the stone will either continue to other crushers further down line, or will be conveyed to a stockpile. Because P.J. Keating Co. produces stone ranging from 24" to 3/8" in size, a variety of secondary crushers and screens must be employed. Furthermore, the crushing process produces many sand and fill products which are often referred to as *fines*.

Fines are sufficiently small enough particles that they travel through the entire crushing process without being screened out. These fines are extracted at the end of the crushing line by means of a wash screw. The fines are deposited into an inclined box full of water. The material is then moved up the inclined box via a spiral screw shaft, causing the particles to come into contact with each other as they travel. This material on material attrition removes any silts, clays, and slimes that are undesirable in the finished washed material. Once removed, these particles are absorbed into the water and discharged. The remaining desired material is dropped onto a conveyor at the end of the augur and conveyed to a stockpile.

3.1.5 Stockpiling

Stockpiling is employed as a means of storing finished product waiting to be sold or utilized. Stockpiles are formed as finished stone product is dropped off of conveyor heads into piles on the yard.

As the product is sold or utilized, it is loaded by front end loaders directly into company or contractor vehicles. For products that are produced in large amounts, P.J. Keating Co. uses radial stockpiling conveyors. These conveyors can be moved in an arc to extend the stockpile side to side, and thus store more material.

3.2   Hot Mix Asphalt Production

P.J. Keating Co. produces HMA through the use of a computerized Astec double-drum type plant, with over 1,000 tons of HMA storage capacity. The process for HMA production through a drum mix plant is divided into five basic stages, described in detail below.

Figure 10: The Lunenburg Asphalt Plant

3.2.1   Cold Feed Bins

The proportioning of the aggregate stone used in HMA production begins with the cold storage bins. The bins are located side by side (separated by dividers) and are used to handle the different sizes of new aggregates. Each bin is top-loaded by a front-end loader continuously throughout the day. The material exits each bin through the bottom, where it is dropped onto a conveyor belt. The amount of material dropped onto the belt from each bin is regulated by belt speed and the electronic control of each bin gate.

3.2.2   Belt Scales and Dryer

Belt scales are used to measure the material deposited onto the belt by the cold storage bins. The belt scale is located under the conveyor and consists of a weight idler and a load cell. The belt is set to run at a specific speed, and a computer calculates the tons of aggregate transported to the dryer by

the accumulated weight over the load cell. The belt scales are particularly important in determining the temperature and fuel consumption of the dryer itself. The dryer is used to remove any water from the mixture components, thus ensuring a proper mix. Too much water compromises the workability and durability of a mixture, through the limitation of the asphalt binder.

3.2.3   Dust Collectors

The drying process creates a small amount of fine aggregate and dust within the system. In order to comply with federal and state air quality codes, emission control equipment is needed to capture any particulates that would otherwise escape into the atmosphere. While there are various types of dust collectors, P.J. Keating Co. makes use of a baghouse to capture and reclaim fine particulates. With a baghouse set-up, exhaust gasses passing through the primary collector are pulled through fabric filters by an exhaust fan. A surge hopper stores these fines and feeds them back into the drum mixer.

3.2.4   Liquid Asphalt Storage

Liquid asphalt storage tanks house the liquid asphalt binder incorporated into the mixture. These tanks are heated and insulated in order to keep them at the proper temperature specified by a supplier. The tanks are heated by transfer oil, which reduces the damage to the final mixture caused by overheating. Transfer oil (a light petroleum product) is heated in a coil heater and piped into the coils of the storage tanks. The coils, located at the bottom of the tank, causes a circulation effect as the heated liquid asphalt rises from the bottom.

3.2.5   Storage Silo

The final stage of HMA production is its relocation to a storage silo. The main purpose of these silos is to temporarily hold the mixture until a transport vehicle arrives. The silos at P.J. Keating Co. are insulated, allowing them to hold HMA for longer periods. After passing through the dryer/mixer, the HMA is pulled up a slat conveyor and deposited into the top of the silos. In order to prevent segregation of materials, a batcher is located at the top of the silo. This device collects one to two tons of mix and deposits it as a mass, allowing it to distribute more uniformly. If not for this device, the HMA would form a conical pile in the center, allowing coarser aggregate to roll down the sides and collect at the bottom, causing an uneven mixture.

3.3   Production Analyses

In order to gain an accurate measure of the production capabilities of two facets of the Lunenburg facility, two separate production analyses are required. The first of these analyses will be conducted on the primary crushing side of the aggregate stone plant, and the second will be conducted on the RAS crushing process. The goal of these analyses will be to evaluate the current plant processes and to propose any changes necessary to create a more efficient and cost effective process.

3.3.1   Primary Crushing

The analysis of the primary crushing portion of the aggregate stone plant will encompass two areas: the load-haul cycle, and the primary crusher itself. The analyses of the load-haul cycle will be conducted through observation hours of the cycle. The cycle will be broken down into seven stages: arrival at the water-down station, departure from the water-down station, back-in to dump, first dump, wait for final dump, final dump, and departure from the primary crusher. Time stamps will be recorded at each of these stages, and then entered into a Microsoft Excel sheet. From these time stamps, the total water-down time, wait time, back-in time, dump time, and wait to dump times, and total times can be determined. The formulas for these time calculations can be found in Appendix C. From these times, idle time and areas of improvement within the process can be identified. This analysis will be conducted based off of 15 observation hours recorded in July of 2012. As a final step, a cost-benefit analysis will be conducted on adjusted fleet sizes and production levels.

The analysis of the primary crusher itself will be based off of data recorded in the PEAK system maintained by Oldcastle and provided by P.J. Keating Co. Through the PEAK system, weekly primary crushing metrics such as scheduled shift hours, down hours, available hours, and units produced can be acquired. These metrics will be compared against ideal production metrics in order to determine the efficiency of the current primary crusher. Included in this comparison will be a cost-analysis of the current primary crusher based on ideal production levels. From these analyses, suggestions for improvement or plant redesign will be made.

3.3.2   Recycled Asphalt Shingle Crushing

In addition to the primary crushing plant analyses, an analysis will be conducted on the RAS crushing process in order to determine the most cost effective and beneficial method for producing the material. A cost analysis will be conducted on P.J. Keating Co.'s current practice of paying a contractor to crush the shingles and will be compared to the theoretical cost of crushing the shingles on their own.

Furthermore, the benefits in using RAS will also be analyzed and used to make recommendations as to how the company should implement RAS.

4.0   Data and Analysis

4.1   Load-Haul Cycle

In order for aggregate stone to be processed it must first be transported from the quarry to the primary crusher. Because this transportation of materials occurs continuously throughout the day, the production output of the plant is entirely dependent on this process. This means that in order to maximize production efficiency and profit, an effective and efficient load-haul cycle is required. For the load-haul analysis on the Lunenburg facility, the current load-haul cycle was observed and analyzed with emphasis placed on total cycle time and tons delivered. Following the current load-haul analysis, alternative load-haul cycles were evaluated based on the use of different equipment, and based on cost. The results of these analyses are detailed below.

4.1.1   Current Load-Haul Cycle

As detailed in the methodology section, the current load-haul cycle was divided into seven separate stages. A time stamp was recorded at each stage and used to calculate the various times for each stage to occur. The process was observed over the course of three days in 2012: July 10, July 12, and July 17. Over these three days, the load-haul cycle was observed for over 15 hours. The results of these observation days are shown in Appendix D.

The most obvious flaw in the process is the fact that each dump from a CAT 777 must occur in two stages. The reason for this occurrence is that the primary box was designed before P.J. Keating Co. had acquired 100-ton haul trucks. The current plant set up is designed for the 85-ton haul trucks that the company used to have. In order to prevent the primary box from being overfilled, the trucks must only dump half their load at a time. The time each truck spends waiting to dump the second time accounts for roughly two minutes and seven seconds of waste time alone. With the average total loop cycle time taking just over 20 minutes, these two minutes of waste time are significant.

Another significant source of waste time within the process occurs when an arriving truck must wait for the previous truck to finish dumping before it can continue through the cycle. Over the three days observed, this accounted for an average of one minute and 32 seconds of total cycle time. Here again we see a significant amount of waste time within the load-haul cycle. While some of this wait time can be attributed to the type of rock being crushed (harder rock types take longer to process through the primary crusher), it indicates a flaw within the process. If trucks are sitting at the primary crusher waiting to dump it indicates one of three possible flaws: the primary crusher is running to slow, the dump time for the truck ahead of the idling truck is too long, or that the front end loader is loading

trucks too quickly and the primary operator cannot keep up with the cycle. While we have already identified the size of the haul trucks as reason for extended idle time within the system, it seems likely that they are largely accountable for the issue of trucks being backed up at the primary crusher.

While waste time within the process has been identified, a second important consideration is the cost of running the equipment needed to complete the load haul cycle. As previously mentioned, the fleet located at Lunenburg consists of three CAT 777 haul trucks loaded by a CAT 992 front end loader. This fleet is occasionally supplemented by a Terex TR70 haul truck. Because this equipment is on the larger side, it costs more to operate and fuel. With the average haul truck and loader operators earning $50.00/hr, haul truck unit costs at $125/hr, and loader unit costs at $130/hr, the current Lunenburg load-haul fleet costs roughly $865.00/hr to operate[73]. However the haul capacity of this fleet allows the company to complete the load haul cycle at a cost of $0.54/ton. This cost per ton is largely what is used to evaluate a particular fleet because it has a direct impact on the amount of profit the company is able to generate.

4.1.2 Alternative Load-Haul Cycles

After observing and analyzing the current Lunenburg fleet, a cost analysis was done on alternative fleet configurations based on production costs. For mathematical ease, these alternative load-haul fleets were configured with Caterpillar equipment and equipment costs provided through their website. Because operating costs and equipment performance is relatively the same across all major brands, and because P.J. Keating Co. largely uses CAT equipment anyway, these still provide an accurate reflection of production costs.

The alternative load-haul fleets were configured with three separate front-end loaders of different bucket capacities: CAT 988H (10 yd^3) CAT 990H (12 yd^3), and CAT 992K (16 yd^3). Additionally, seven separate haul truck models were used each with different payload capacities: CAT 770 (40 tons), CAT 770G (42.6 tons), CAT 772 (56 tons), CAT 772G (57.2 tons), CAT 773G (67 tons), CAT 775G (77.5 tons), and CAT 777G (109.6 tons). Cost and production analyses were run for each of these haul truck models paired with each of the front-end loader models, with fleet sizes ranging from one loader and one truck to one loader and four trucks. An analysis was conducted on each fleet configuration, taking each stage of the load-haul cycle into account. These analyses can be found in Appendix E.

The first thing we notice about these fleet analyses is that as the size of the loader increases, the cost per ton of stone decreases. While this is to be expected, it is also misleading. While maximizing the

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[73] Costs obtained through collaboration with P.J. Keating Co.

amount of stone hauled to the primary crusher is ideal, it is necessary to take into account the capacity of the crusher itself. Maximizing the inflow of stone to the crusher is irrelevant if it causes idle time within the system.

A second consideration within the configurations was human error. Because all of the times used within the analysis were idealized, they do not take into account the workers operating the machinery. For example, an operator loading a CAT 777G haul truck with a CAT 988H loader would likely take longer than the projected time of just over six minutes to load the truck. This is because safety would necessitate that the loader operator be more cautious when using a loader that is undersized for a particular truck model. The same can be said for an operator using an oversized loader for an undersized truck model.

A final consideration within the fleet configuration is safety. Maximizing the amount (and size) of haul trucks within the cycle seems ideal, the safety of operating the equipment must be taken into consideration. Because the haul road is a fixed width, larger haul trucks provide less room for travel, particularly when passing each other. Larger equipment would require drivers to be more cautious on the roads, and therefore travel slower. This can have a negative effect on cycle time, and therefore limit production. Additionally, larger equipment accelerates the deterioration of the haul road, requiring higher maintenance costs. Because of this it is important to balance the fleet configuration with anticipated maintenance costs.

4.2   Primary Crusher Analysis

As detailed in the methodology section, the analysis of the primary crusher was conducted using data obtained from the PEAK system utilized by P.J. Keating Co. to measure plant production. Data was acquired for the years ranging from 2009 to 2012 for analyses and comparison. The data acquired included information pertaining to the Produced Units, Theoretical Produced Units, Operated Hours, Scheduled Hours, Downtime Hours, Units per Operated Hour, Units per Scheduled Hour, Availability, Overall Equipment Effectiveness (OEE), and Production Lost to Downtime for each day that the plant operated over the previously mentioned time span. This data can be found in Appendix F.

Yearly Totals	Produced Units	Theo. Produced Units	Operated Hours	Scheduled Hours	Downtime Hours	Units Per Operated Hour	Units Per Scheduled Hour	Availability	OEE	Production Lost to Downtime
2009	893,433	1,404,147	1,163	1,503	191	755	577	75.91	61.70	182,035
2010	848,810	1,123,866	1,542	1,748	155	548	485	88.38	75.44	96,184
2011	697,633	906,137	1,148	1,305	134	601	528	87.86	75.50	89,866
2012	539,183	705,065	1,246	1,682	339	424	315	74.46	76.79	139,884

Figure 11: Table Displaying Yearly Primary Crushing Totals

For comparison purposes, the metrics listed above were totaled for each month and then again for each year. The analysis of the primary crusher was conducted off of these yearly tables, shown in the figure below.

The first thing noticed when analyzing this table is that plant production has fallen dramatically over these four years, while the operated hours have remained relatively the same. This means that the plant is operating less efficiently, a fact confirmed by the units per operated hour statistic. While the decrease in plant efficiency has an obvious effect on the output of the plant, it also has an important financial impact as well. Lowered plant output minimizes the company's ability to generate profit.

Because the plant is operating for roughly the same amount of time each year, the cost of running it remains relatively constant. In order to cover these operating costs with a lowered inventory, the company must either increase their product prices or take a financial loss. An increase in product prices would make the company less competitive in bidding projects. Because project bids are largely dependent on price and time, the potential loss of these products would constitute further negative financial impact on the company. Since P.J. Keating relies heavily on the profits of state and private contracts, it is essential to their success that they remain competitive in those areas.

The second alternative of operating at a financial loss is not a sustainable business model for obvious reasons. While the existence of sister locations at Dracut, Cranston, and Acushnet can make up for the loss at the Lunenburg site over a short period of time, in the long run it is not desirable. This is particularly true when we consider the fact that the Lunenburg facility is the company's flagship plant and is capable of producing the most stone. As the company's leading capable producer, it is crucial that Lunenburg be able to maximize its production potential in order to serve its customer base. As the flagship plant it is also important for the Lunenburg plant to set a good example for the company and the customer base.

In addition to the drop in production, the above table also indicates a significant amount of downtime over the past four years, with 339 in 2012 alone. This downtime can largely be attributed to the age of the equipment in the plant and its lack of proper maintenance over the years. The increase in downtime is largely responsible for the significant drop in production and the subsequent loss of profit.

In addition to this lost profit, equipment downtime also increases maintenance and replacement part costs, further impacting the company financially.

In an effort to quantify the financial impact the operating efficiency and equipment downtime has on the Lunenburg plant, a cost analysis was conducted. This analysis compared ideal production metrics to those calculated over the past four years, and calculated an estimated profit loss due to the drop in production. This analysis was based on the company's target goal of producing 800 tons per hour, and the gross profit of $6.56 per ton[74]. The results of this analysis are shown in the figure below.

Year	Units Produced	Theoretical Units Produced	TPSH	TPSH Target	TPSH Loss	TPOH	TPOH Target	TPOH Loss	Production Lost to Downtime	Loss to Downtime
2009	893,433	1,404,147	577	800	$1,463.88	755	800	$295.44	182,035	$1,194,150.65
2010	848,810	1,123,866	485	800	$2,069.36	548	800	$1,651.45	96,184	$630,967.70
2011	697,633	906,137	528	800	$1,781.64	601	800	$1,306.90	89,866	$589,518.60
2012	539,183	705,065	315	800	$3,183.96	424	800	$2,467.16	139,884	$917,636.42

Figure 12: Primary Crushing Cost Analysis

The values for Tons per Scheduled Hour (TPSH) Loss and Tons per Operated Hour (TPOH) Loss represent the average amount of potential profit lost by the company for each hour scheduled/operated in a particular year. In an ideal system, there is no downtime for repairs or maintenance and therefore the TPSH and TPOH are equal. However, because downtime does occur in a real-life application the TPSH is higher than TPOH. This is reflected in the difference in Loss numbers, with TPOH loss being less than TPSH loss as expected. Although these values represent a comparison to an ideal plant without any scheduled downtime or repairs, they serve as an indicator to the cost of inefficient production.

A second significant factor in the cost analysis is the loss due to downtime. This value represents the loss of potential profit because the plant was shut-down for repairs. These calculated costs represent a significant amount of profit loss over the course of a year and constitute the best evidence as to the financial impact of aging equipment. While not all of this downtime can be contributed to issues within the primary crusher, poor crushing performance can lead to maintenance issues further down line.

4.3 Crushed Shingle Analysis

Presently, P.J. Keating Co. employs contractors to crush their asphalt shingles, at a cost of roughly $18.00 per ton of material[75]. The cost analysis conducted for the crushed shingles compares the cost of purchasing and using an asphalt crusher to previously mentioned cost of paying a contractor. The analysis is conducted on the assumption that one loader operator will be needed to operate a

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[74]Numbers attained through coordination with P.J. Keating Co.
[75] Price point obtained through collaboration with P.J. Keating Co.

mobile asphalt shingle crusher capable of producing 75-85 tons of RAS per hour. Two separate analyses are conducted below, providing for the two options P.J. Keating Co. would have. The first analysis calculates savings induced through use of RAS in the company's own asphalt mix. The second analysis calculates savings induced by selling the RAS mix to a separate paving company.

Example 1

An asphalt paving company grinds shingle waste to supplement the virgin asphalt cement (AC) used in paving mixes, lowering their costs.

Input variables

AC content of shingles = 20%
AC value = $350 per ton
Processing rate = 75 tons of ground shingles per hour
Tipping fee = $18 per ton

75 tons of ground shingles per hour x 20% AC content = 15 tons of AC processed per hour
15 tons of AC x $350 per ton = $5,250
75 tons per hour x $18 per ton tipping fee = $1,350
$5,250 + $1,350 = $6,600 per hour

Example 2

A waste handling company grinds tear-off shingles and sells the ground material to an asphalt paving company.

Input variables

AC content of shingles = 25%
AC value = $250 per ton
Processing rate = 75 tons of ground shingles per hour
Tipping fee = $18 per ton

75 tons of ground shingles per hour x 25% AC content = 18 tons of AC processed per hour
18 tons of AC x $250 per ton = $4,500
75 tons per hour x $18 per ton tipping fee = $1,350
$4,500 + $1,350 = $5,850 per hour

The above values of $6,600 and $5,850 per hour represent the total savings in asphalt cement and contractor costs through use of their own crusher. The examples do not take into account operating costs. The formula for the anticipated operating costs is shown below.

Input Variables

Loader Unit Cost = $95 per hour (assuming CAT 988 loader)
Labor Cost = $50 per hour
Crusher Cost = $200 per hour[76]

Operating Cost = $95 + $50 + $200 = $345 per hour

When we take the total operating cost of $345 per hour into account, the total savings values become $6,255 and $5,505 for each scenario respectively. For further comparison, if we divide the total operating cost by the expected output of at least 75 tons per hour, we see that the total cost per ton of RAS is $4.60 per ton. This represents a savings of $13.60 per ton over the use of a contract crusher.

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[76] Cost obtained through collaboration with multiple crushed shingle contractors

5.0   Recommendations and Conclusion

The previous sections have provided information regarding the evaluation and assessment of the P.J. Keating Co. facility in Lunenburg, MA. We have looked into how the plant operates and identified areas for improvement within the aggregate stone and asphalt production processes. In this section several recommendations will be provided for ways to tangibly improve the production processes while minimizing cost. These recommendations have been divided into three specific parts: future plant improvements, the implementation of Lean Six Sigma, and compliance with environmental guidelines.

The recommendations for future plant improvements center largely about the areas analyzed within the report. From the cost benefit and production analyses conducted on the load-haul cycle, primary crusher, and crushed shingle process, recommendations are provided for how the plant can be modified or adjusted to improve these processes. In most cases these adjustments seek to lower long-term costs and improve the efficiency of the plant. In some cases, multiple recommendations are made for the solution to a single problem, with the benefits and drawbacks of each being discussed.

The section on the implementation of Lean Six Sigma discusses the benefits of implementing a Lean system within the Lunenburg, MA facility. The section discusses how such a system could be implemented and how the implementation of such a system would affect plant production. Finally, this section discusses the managerial impact of implementing such a system, and proposes recommendations on how to address any issues that may arise from it.

The final section of recommendations focuses on the compliance with environmental guidelines moving forward. This section stresses the importance of complying with these guidelines as any changes are made to the plant, as well as discussing the importance of environmental compliance. In this section the short and long term benefits of environmental compliance are also discussed.

5.1   Future Plant Improvements

This section details the proposed recommendations for improving the operation of the Lunenburg, MA facility. These recommendations are divided into three separate sections: load-haul fleet reconfiguration, primary crushing, and shingle crushing. In these sections recommendations for improving plant operation and efficiency are proposed and discussed.

5.1.1   Load-Haul Fleet Reconfiguration

After assessing of the load-haul cycle, it has been observed that the current Lunenburg fleet of three CAT 777 haul trucks, one Terex TR70 haul truck, and one CAT 992 front end loader is not ideally

suited to the current plant set up. This can be contributed largely to the fact that the stone processing plant was not designed for equipment of this size and scale. Because the equipment is oversized for the plant, it creates a bottleneck in the crushing process at the primary crusher. This is particularly evident in the required two-stage dumping process, and the resulting idling time by haul trucks.

The problem caused by having an oversized fleet is two-fold. First, the cost of production is increased. This occurs because the primary crusher cannot keep up with the pace of trucks arriving at the hopper. The bottleneck formed at the primary crusher results in trucks idling as the wait to dump their load. This idle time translates as lost opportunity costs because money is being spent to operate the equipment, but it is not producing. This bottleneck also creates idle time for the front-end loader in the quarry, which must wait for the haul trucks to dump before reloading them. Secondly, this oversized fleet lowers production efficiency by placing unneeded pressure on the primary booth operator, who is in control of the primary crusher and the other crushers across the plant. As the trucks pile up at the primary crusher, pressure is created for him to perform his job faster. In many cases this causes him to over-extend the capabilities of the primary crusher, increasing the chance for equipment malfunction or damage, and it also causes him to neglect his other duties within the booth. This neglect can result in stopped belts, crusher overflows, and a failure to identify other plant hazards. All of these factors slow production and lower efficiency, all of which contribute to lower profit potential.

The recommendation proposed for P.J. Keating Co. is to downsize the fleet from three CAT 777 haul trucks, one Terex TR70, and one CAT 992 front-end loader to four CAT 775G haul trucks and one CAT 992 front-end loader. Although this would lower the payload of each haul truck from 109.6 tons to 77.5 tons, it would work to increase plant efficiency by eliminating idle time. The largest benefit to these smaller haul trucks is that they are more ideally suited to the current plant set-up, which was designed for 85 ton haul trucks. This reconfiguration of the fleet would mean that each truck would be able to complete its dump in one stage at the primary crusher. This would eliminate the two minutes and seven seconds of wait time caused by the CAT 777s. Downsizing the fleet would also mean that the time required to load each haul truck would be dramatically reduced. This reduced time would allow each truck to complete an entire cycle in less time, allowing each truck to complete more loads per hour. This enables efficiency to be increased in a way that does not place unnecessary strain on the equipment or primary booth operator.

A second benefit to downsizing the fleet would be lowering the operating cost of the equipment. With the current fleet set-up, P.J. Keating Co. is spending $865.00/hr in unit and labor costs

for the equipment, while hauling an estimated 1593.35 tons per hour[77]. By downsizing, P.J. Keating Co. would lower the unit and labor costs to $780.00/hr, while still being able to haul an estimated 1320.52 tons per hour[78]. While the total tons per hour is lowered, it is important to keep in mind that these values are calculated under ideal situations, and do not take idle time into account. This means that the 1593.35 tons produced by the current fleet is likely inflated, as we identified numerous instances in idle time through observation. Because the CAT 775s are able to dump in one stage, the estimated 1320.52 tons per hour for the proposed fleet is likely to be closer to the true value.

The largest obstacle faced when considering downsizing the fleet is the cost associated with acquiring for new haul trucks. While these vehicles can be purchased new from the factory, at a cost of hundreds of thousands of dollars, a more feasible solution would be to swap them with another aggregate stone plant within the Oldcastle Corporation. Although this would likely require more time, as four CAT 775s would need to be made available, it would minimize the cost of reconfiguration.

Another consideration in resizing the fleet is future plant improvements and layout. The recommended fleet configuration is based off of the current layout of the Lunenburg, MA facility. If the plant were to be adjusted to drastically increase production, the proposed fleet could handicap production. While a plant redesign of that scale is likely to take a significant amount of time and would allow for a fleet adjustment, it is important to consider the long term implications of such a reconfiguration. If the long term goal of the Lunenburg, MA facility is to significantly increase production, then a downsized fleet would hinder production. Because of this it is important to formulate a clear long term goal for the facility before implementing any changes.

5.1.2   Primary Crushing

Based on the production and cost analyses conducted on the primary crushing side of the plant, it is recommended that the company work to replace the primary crusher currently in use. The age and maintenance requirements of the current machine mean that the cost of repairing it completely would not be significantly low enough that it would outweigh the cost of replacing the machine completely. Based on this assumption, two suggestions for replacing the current primary crusher are outlined below.

5.1.2.1 In-Place Replacement

The first alternative would be to replace the current primary crusher with a similar model. This would allow the company to keep the current set-up of the plant the same, while also minimizing

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[77] Number attained through spreadsheet located in Appendix E
[78] Ibid.

replacement costs. While a gyratory crusher of a similar size would be the most cost effective, the company could also explore the use of jaw crushers. The use of a jaw crusher would minimize the use of the hydraulic hammer located at the primary hopper, and would save future maintenance costs.

While the use of an in-lace replacement crusher would be the most cost-effective short term solution, it would mean that the plant could not operate during the process of installing the new machinery. This could result in potential profit loss should the installation carry into the operating months of March through November. It would also mean that the load-haul fleet would need to be catered to the proposed design. An increase in crushing capacity would necessitate the need for larger equipment and increased blasting. Furthermore, by keeping the crusher where it currently is situated, the load-haul distance would continue to be the same. While the roughly one-mile loop is by no means outrageous, the constant travel of the vehicles increases equipment and road maintenance costs.

5.1.2.2 In-Pit Crusher

The second alternative would be to relocate the primary crusher to the quarry itself. By doing this the need for a load-haul cycle would be eliminated, significantly reducing equipment costs. Relocating the primary would also allow the plant to continue to operate as the new machinery is installed. This would ease the transition of the plant and minimize any lost profit potential due to installation problems and delays.

The downside in relocating the primary crusher is the need to convey the material to the processing side of the plant. This would require conveying equipment to either be installed along the current load-haul route, or for the processing equipment to be relocated closer to the quarry. While the second of these two scenarios is ideal, it would require significant costs for clearing the land, acquiring the proper building permits, and re-locating the equipment. Furthermore this would require significant financial backing from the company in addition to the costs of a new primary crusher.

While the financial considerations of redesigning the plant around an in-pit crusher are significant, it offers the best profit potential for the company in the long-run. Because the crusher would be located as close to the quarry as possible, the output of the plant would increase significantly. When combined with the savings induced through the elimination of an extended load-haul cycle, the increased profit margin of the material would allow the company to make their money back in a relatively short amount of time.

5.1.3 Shingle Crushing

Based on the cost analysis conducted, it is recommended that P.J. Keating Co. work to integrate their own shingle crushing machinery within the Lunenburg plant. With potential savings of over $10 per ton of shingles crushed the financial incentive of operating a mobile shingle crushing plant on-site is extremely appealing financially. Though the cost of purchasing or renting the machinery can be expensive, the long-term monetary savings outweigh the short-term costs.

Figure 13: Example RAS Crusher

In addition to the financial benefits of on-site crushing, the elimination of contract crushing also provides much more convenience for the company. Because shingle crushing can be conducted continuously throughout the year, P.J. Keating Co. will not have to tailor their production to the schedule of the contractor. This will eliminate the potential for running out of RAS on-site, and will increase flexibility within the asphalt production plant where the RAS is utilized.

A final benefit to the use of an on-site crushing plant is the ability to have complete control over the crushing process. This means that the company can better tailor the final product to their desired specifications, while also allowing them to produce RAS in a manner that is the most beneficial financially. Production can be slowed during months with high operating costs in other areas of the plant, and increased during slower months. Additionally, the company can choose to increase production enough to sell of the extra product, giving them further financial flexibility.

While the scenario conducted within the cost analysis utilized a crusher capable of 75-85 tons per hour, the machine should be tailored to the RAS use of the plant. Because the cost analysis was calculated on a cost per ton basis, the savings should be similar across the different sizes and outputs of machinery. While the process of contracting the crushing can be seen as more convenient, it lowers the flexibility of the plant. This flexibility is crucial in minimizing waste and maximizing efficiency on-site.

5.2   Implementation of Lean Six Sigma

While P.J. Keating Co. has implemented some aspects of Lean Six Sigma at the Lunenburg, MA facility through Toolbox Talks and some 5s practices, a more committed approach would serve to increase productivity and plant efficiency. In order to properly introduce this system into the facility, it is recommended that the company certify their management staff in Lean Six Sigma, or alternatively hire

a certified consultant to introduce the system to them. Having certified individuals implement the process into the company will not only ensure that the process goes as smoothly and effectively as possible, but it will also signify to the laborers that the company is serious about their approach toward eliminating waste within the process.

It is suggested that the introductory phases of Lean Six Sigma implementation be focused on creating a more visual workplace and working to implement 5s within the facility. While these two steps often go hand-in-hand, their implementation accomplishes separate goals. By creating a more visual workplace, the company is able to once again assert the commitment to Lean Six Sigma to the laborers. Additionally, visual cues help to develop and establish proper long term work procedures and habits, helping management to reinforce a standard operating procedure that is consistent over time.   Finally, a visual workplace places emphasis on safety by bringing awareness to daily tasks. This emphasis on safety is particularly important in the aggregate industry where occupational hazards are higher. A focus on safety also helps to create buy-in from employees.

The implementation of 5s within the facility is important in minimizing wasted time and effort during shifts. By organizing the workplace in a logical way, time spent looking for materials and supplies are minimized. This is especially relevant within an aggregate stone plant where maintenance is being conducted continuously, and tools and equipment are frequently shared. 5s organization also helps to promote the longevity of tools and equipment, further minimizing repair and maintenance costs long-term. Finally, implementing 5s will create a cleaner workplace for employees. This will result in a happier workforce which can, in turn, translate to a more productive workforce. A cleaner facility will also be more visually appealing to neighbors and visitors to the site. Having a positive impact on neighbors is important in promoting the integration of P.J. Keating Co. into the community.

The biggest challenge in implementing a Lean Six Sigma system within any company is resistance faced by employees. Because P.J. Keating Co. has a significant number of employees who have worked there for extended periods of time, the resistance to change is likely to be higher. The best way to overcome this obstacle is to have a focused and targeted effort by the senior managers within the plant. By showing commitment and investment in the system employee uneasiness can be calmed.

Another way in which to overcome resistance to the institution of a Lean Six Sigma process is to keep employees and laborers updated on the progress made as a result of the change. This entails not only updating individuals via meetings and Toolbox Talks, but also by communicating with them on a one-on-one basis. Through these personal interactions issues can be more properly addressed, and individual employee buy-in can be strengthened. Furthermore, facilitating employee feedback and

ideas for improvement eases the implementation of change. Not only does it allow the individual to voice their opinion, but it also serves to strengthen the system. Employees are often the best sources of ideas for improvement because they are the ones executing the individual tasks each day.

5.3   Summary

The above section outlines the multiple recommendations and conclusions drawn from the performance and cost analyses conducted on P.J. Keating Co.'s aggregate stone and asphalt plant located in Lunenburg, MA. Ways of improving the efficiency and effectiveness of plant operation were suggested through the continuation of Lean Six Sigma practices, the reconfiguration of the load-haul fleet, proposed alterations to the primary crushing side of the plant, and through the recommendation of on-site asphalt shingle crushing. The successful implementation of these recommendations could have a positive long term effect on the operating efficiency and costs of the plant.

6.0   End Notes

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Appendix A: Products Produced by P.J. Keating in Lunenburg

Mixes

Base Course Mixes

State Dense Binder
Use as a base course on properly prepared soil sub-base for high-load bearing roadways and commercial parking lots. Minimum Lift Thickness 1 1/2"
Maximum Lift Thickness 2 1/2"

Driveway Binder
Use as a base course on properly prepared soil sub-base for low to medium load-bearing driveways and parking lots.
Minimum Lift Thickness 1 1/2"
Maximum Lift Thickness 2 1/2"

Top Course Mixes

State Top
Use as a top course for high load-bearing roadways, parking lots and driveways.
Minimum Lift Thickness 1 1/4"
Maximum Lift Thickness 2"

3/8" Driveway Top
Use as a top course for low to medium load-bearing driveways.
Minimum Lift Thickness 1"
Maximum Lift Thickness 1 1/4"

3/8" Parking Lot Top
Use as a top course for low to medium load-bearing parking lots.
Minimum Lift Thickness 1"
Maximum Lift Thickness 1 1/4"

Special Mixes

Sidewalk Top
Use as a top course for sidewalk construction.
Minimum Lift Thickness 1"
Maximum Lift Thickness 1 1/4"

Berm Mix
Use for constructing bituminous concrete curbs.

Crushed Stone Products

Wall Stone

12" - 24" Stone

12" – 18" RIP RAP

6" - 10" Stone

4" – 10" Stone

2" - 4" Stone

2" Stone

1 1/2" Crushed Stone

3/4" Crushed Stone

3/4" Washed Stone

1/2" Crushed Stone

1/2" Washed Stone

3/8" Crushed Stone

3/8" Washed Stone

Crushed Base & Borrow Products

1 1/2" Dense Graded Base

3/4" Graded Base

3" Brown Processed

1 1/2" Brown Processed

3/4" Brown Processed

Recycled Base Products

Recycled K -Base

K-RAP Base

RAP Base

Graded RAP Base

Grindings

Sand & Fill Products

Screened Sand

Mason Sand

Concrete Sand

Stone Sand

Washed Dust

Stone Dust

Fill

Silt

Appendix B: Companies in the Northeast Division of Oldcastle Materials

Connecticut

Buchanan Marine
39 Ferry Street
New Haven, CT 06513
(203) 466-0484, (203) 466-2272 fax

Tilcon Connecticut, Inc.
642 Black Rock Avenue
New Britain, CT 06052
P.O. Box 1357
New Britain, CT 06050
(860) 223-3651, (860) 225-1865 fax
www.tilconct.com

301 Hartford Avenue
Newington, CT 06111
(860) 756-8068, (860) 756-8059 fax

Maine

Pike Industries
58 Main Street
Westbrook, ME
(207) 854-2561, (207) 854-2539 fax
www.pikeindustries.com

Massachusetts

Clemente Fane Concrete
320 Hubbard Ave
Dalton, MA 01226
(800) 816-8151, (413) 499-4506 fax

Pittsfield Sand & Gravel
1530 East Street
Pittsfield, MA 01201
(413) 443-4729, (413) 445-7753 fax

Bushika Sand & Gravel
926 North Street Road
Cheshire, MA 01225
(413) 443-4729

P.J. Keating Company
998 Reservoir Road
Lunenburg, MA 01462
(978) 582-5200, (978) 582-7130 fax
www.pjkeating.com

New Hampshire

Pike Industries
3 Eastgate Park Road
Belmont, NH 03220
(603) 527-5100, (603) 527-5101 fax
www.pikeindustries.com

Redimix Companies, Inc.
32 Bay Road
Sanbornton, NH 03269
(603) 524-4434, (603) 524-8711 fax
www.redimixcompanies.com

New Jersey

Tilcon New York Inc.
New Jersey Division
625 Mount Hope Road
Wharton, NJ 07885
(973) 366-7741, (973) 659-3929 fax
www.tilconny.com

Bedrock Quarry

Gallo Asphalt

Mount Hope Rock Products

Passaic Crushed Stone

New York

Callanan Industries, Inc.
1245 Kings Road
P.O. Box 15097
Albany, NY 12212-5097
(518) 374-2222, (800) 446-8649
(518) 374-1721 fax
www.callanan.com

Clemente Latham Concrete
1245 Kings Road
P.O. Box 15097
Albany, NY 12212-5097
(518) 374-0299, (518) 346-0808 fax
www.callanan.com

Dolomite Group
1150 Penfield Road
Rochester, NY 14625
(585) 381-7010, (585) 381-0208 fax
www.dolomitegroup.com

Clemente Fane Concrete
8473 State Route 69
Oriskany, NY 13424
(315) 736-9636, (315) 736-1470 fax

Manitou Concrete
1260 Jefferson Road
Rochester, NY 14623
(585) 424-6410, (585) 424-1846 fax

Northrup Materials
58 Owens Road
Brockport, NY 14420
(585) 637-3939, (585) 637-5619 fax

Tilcon New York Inc.
New York Division
162 Old Mill Road
West Nyack, NY 10994
(845) 358-4500, (845) 480-3231 fax
www.tilconny.com

A. L. Blades
6375 Tuttle Road
Canastota, NY 13032
(315) 697-3367, (315) 697-7501 fax

Rhode Island

P.J. Keating Company
875 Phenix Avenue
Cranston, RI 02921
(401) 942-7300, (401) 943-2780 fax
www.pjkeating.com

Vermont

Pike Industries
249 Granger Road
Barre, VT 05641
(802) 223-3002, (802) 223-3175 fax
www.pikeindustries.com

Appendix C: Load-Haul Cycle Calculation Formulas

Water Time

$$Arrive\ at\ Water\ - Leave\ Water\ = Water\ Time$$

Wait Time

$$Back\ in\ to\ Dump\ - Leave\ Water\ = Wait\ Time$$

Back-In to Dump Time

$$First\ Dump\ - Back\ in\ to\ Dump = Back\ in\ to\ Dump\ Time$$

First Dump Time

$$Wait\ Dump\ - Dump = First\ Dump\ Time$$

Wait Dump Time

$$Final\ Dump\ - Wait\ to\ Dump = Wait\ Dump\ Time$$

Total Time

$$Leave\ Hopper\ - Arrive\ at\ Water = Total\ Time$$

Appendix D: Load-Haul Cycle Observation Results

July 10, 2012

	Truck #	Driver	Arrive at Water	Leave Water	Back-in to Dump	First Dump	Wait to Dump	Final Dump	Leave Hopper		End Stamp	Water Time	Wait Time	Back-in to Dump Time	First Dump Time	Wait Dump Time	Final Dump Time	Total Time
1	Truck 1	Ricky	7:19:58	7:20:34	7:21:08	7:22:12	7:22:38	7:25:02	7:25:21		7:25:21	0:00:36	0:00:34	0:01:04	0:00:26	0:02:24	0:00:19	0:05:23
2	Truck 2	Roger	7:23:57	-	7:25:50	7:29:08	-	-	7:31:00		7:31:00	#VALUE!	0:01:53	0:03:18	0:01:52	#VALUE!	#VALUE!	0:07:03
3	Truck 3	Dave	7:29:17	7:29:57	7:32:15	7:36:39	7:37:02	7:39:28	7:39:57		7:39:57	0:00:40	0:02:18	0:04:24	0:00:23	0:02:26	0:00:29	0:10:40
4	Truck 4	Norm	7:34:36	7:35:20	7:40:25	7:42:00	7:43:15	7:45:02	7:45:35		7:45:35	0:00:44	0:05:05	0:01:35	0:01:15	0:01:47	0:00:33	0:10:59
5	Truck 1	Ricky	7:41:18	7:41:58	7:46:05	7:49:19	7:49:45	7:53:58	7:54:10		7:54:10	0:00:40	0:04:07	0:03:14	0:00:26	0:04:13	0:00:12	0:12:52
6	Truck 2	Roger	7:47:18	-	7:48:38	7:49:10	-	-	7:50:22		7:50:22	#VALUE!	0:01:20	0:00:32	0:01:12	#VALUE!	#VALUE!	0:03:04
7	Truck 3	Dave	7:53:47	7:54:22	7:55:25	7:56:17	7:56:35	7:58:47	7:59:19		7:59:19	0:00:35	0:01:03	0:00:52	0:00:18	0:02:12	0:00:32	0:05:32
8	Truck 4	Norm	8:00:52	8:01:33	8:02:24	8:02:36	8:02:58	8:04:32	8:05:06		8:05:06	0:00:41	0:00:51	0:00:12	0:00:22	0:01:34	0:00:34	0:04:14
9	Truck 1	Roger	8:05:26	-	8:05:47	8:06:22	-	-	8:07:31		8:07:31	#VALUE!	0:00:21	0:00:35	0:01:09	#VALUE!	#VALUE!	0:02:05
10	Truck 2	Ricky	8:09:48	8:10:23	8:10:56	8:11:16	8:11:41	8:14:29	8:14:47		8:14:47	0:00:35	0:00:33	0:00:20	0:00:25	0:02:48	0:00:18	0:04:59
11	Truck 3	Dave	8:17:34	8:18:09	8:18:44	8:19:11	8:19:36	8:20:56	8:21:27		8:21:27	0:00:35	0:00:35	0:00:27	0:00:25	0:01:20	0:00:31	0:03:53
12	Truck 4	Norm	8:51:14	8:51:52	8:52:38	8:53:03	8:53:24	8:54:57	8:55:30		8:55:30	0:00:38	0:00:46	0:00:25	0:00:21	0:01:33	0:00:33	0:04:16
13	Truck 1	Ricky	8:58:00	8:58:36	8:59:08	8:59:26	8:59:40	9:02:21	9:02:42		9:02:42	0:00:36	0:00:32	0:00:18	0:00:14	0:02:41	0:00:21	0:04:42
14	Truck 2	Roger	9:01:37	-	9:02:03	9:02:30	-	-	9:03:28		9:03:28	#VALUE!	0:00:26	0:00:27	0:00:58	#VALUE!	#VALUE!	0:01:51
15	Truck 3										0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00
16	Truck 4										0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00
17	Truck 1										0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00
										Average	0:00:38	0:01:27	0:01:20	0:00:42	0:02:18	0:00:26	0:06:08
										Maximum	0:00:44	0:05:05	0:04:24	0:01:15	0:04:13	0:00:34	0:12:52
										Minimum	0:00:35	0:00:32	0:00:12	0:00:14	0:01:20	0:00:12	0:02:05

Notes: Roger on 70-ton hauling brown dirt (dump middle/no wash) — Ricky 4 loads; Roger 4 loads; Dave 3 loads; Norm 3 loads
Break between cycle 11 and 12
7' Standard down after 14

July 12, 2012

Notes: 3 100 ton trucks until cycle 17 — Two trucks (70 and 100) from cycle 32 to 35
Coffee break between cycles 5 and 6 — Kenny 12 loads; Dave 12 loads; Ricky 14 loads; Norm 8 loads
8x20 tripped off after cycle 28 — Norm on 70-ton

	Truck #	Driver	Arrive at Water	Leave Water	Back-in to Dump	First Dump	Wait to Dump	Final Dump	Leave Hopper		End Stamp	Water Time	Wait Time	Back-in to Dump Time	First Dump Time	Wait Dump Time	Final Dump Time	Total Time
1	Truck 1	Kenny	8:04:12	8:04:54	8:06:21	8:06:56	8:07:30	8:09:33	8:10:17		8:10:17	0:00:42	0:01:27	0:00:35	0:00:34	0:02:03	0:00:44	0:06:05
2	Truck 2	Dave	8:07:57	8:08:34	8:10:30	8:13:11	8:13:34	8:16:06	8:16:40		8:16:40	0:00:37	0:01:56	0:02:41	0:00:23	0:02:32	0:00:34	0:08:43
3	Truck 3	Ricky	8:13:53	8:14:28	8:17:02	8:19:49	8:20:10	8:22:03	8:22:21		8:22:21	0:00:35	0:02:34	0:02:47	0:00:21	0:01:53	0:00:18	0:08:28
4	Truck 4	Kenny	8:24:40	8:25:18	8:25:53	8:26:21	8:26:41	8:28:51	8:29:14		8:29:14	0:00:38	0:00:35	0:00:28	0:00:20	0:02:10	0:00:23	0:04:34
5	Truck 1	Dave	8:28:58	8:29:38	8:30:17	8:33:02	8:33:26	8:35:26	8:35:57		8:35:57	0:00:40	0:00:39	0:02:45	0:00:24	0:02:00	0:00:31	0:06:59
6	Truck 2	Ricky	8:59:45	9:00:23	9:00:51	9:01:38	9:01:56	9:04:23	9:04:55		9:04:55	0:00:38	0:00:28	0:00:47	0:00:18	0:02:27	0:00:32	0:05:10
7	Truck 3	Kenny	9:17:44	9:18:23	9:18:58	9:20:09	9:20:31	9:23:13	9:23:36		9:23:36	0:00:39	0:00:35	0:01:11	0:00:22	0:02:42	0:00:23	0:05:52
8	Truck 4	Dave	9:22:05	9:22:47	9:23:58	9:26:21	9:26:56	9:28:56	9:29:26		9:29:26	0:00:42	0:01:11	0:02:23	0:00:35	0:02:00	0:00:30	0:07:21
9	Truck 1	Ricky	9:26:03	9:26:50	9:29:49	9:32:19	9:32:36	9:34:35	9:34:49		9:34:49	0:00:47	0:02:59	0:02:30	0:00:17	0:01:59	0:00:14	0:08:46
10	Truck 2	Kenny	9:37:31	9:38:07	9:38:41	9:39:10	9:39:45	9:42:53	9:43:18		9:43:18	0:00:36	0:00:34	0:00:29	0:00:35	0:03:08	0:00:25	0:05:47
11	Truck 3	Dave	9:43:58	9:44:34	9:45:06	9:45:56	9:46:15	9:49:48	9:50:19		9:50:19	0:00:36	0:00:32	0:00:50	0:00:19	0:03:33	0:00:31	0:06:21
12	Truck 4	Ricky	9:50:00	9:50:33	9:51:06	9:52:44	9:53:01	9:55:23	9:55:41		9:55:41	0:00:33	0:00:33	0:01:38	0:00:17	0:02:22	0:00:18	0:05:41
13	Truck 1	Kenny	9:57:01	9:57:45	9:58:17	9:58:46	9:59:09	10:01:50	10:02:14		10:02:14	0:00:44	0:00:32	0:00:29	0:00:23	0:02:41	0:00:24	0:05:13
14	Truck 2	Dave	10:04:30	10:05:02	10:05:36	10:06:14	10:06:31	10:09:31	10:10:00		10:10:00	0:00:32	0:00:34	0:00:38	0:00:17	0:03:00	0:00:29	0:05:30
15	Truck 3	Ricky	10:10:16	10:10:57	10:11:37	10:11:59	10:12:13	10:14:04	10:16:15		10:16:15	0:00:41	0:00:40	0:00:22	0:00:14	0:01:51	0:02:31	0:06:19
16	Truck 4	Kenny	10:17:30	10:18:12	10:18:49	10:22:45	10:23:36	10:25:38	10:26:07		10:26:07	0:00:42	0:00:37	0:03:56	0:00:51	0:02:02	0:00:29	0:08:37
17	Truck 1	Norm	10:21:20	10:21:51	10:26:37	10:29:21	-	-	10:30:57		10:30:57	0:00:31	0:04:46	0:02:44	0:01:36	#VALUE!	#VALUE!	0:09:37
18	Truck 2	Dave	10:25:12	10:25:45	10:31:20	10:34:15	10:34:42	10:36:14	10:36:48		10:36:48	0:00:33	0:05:35	0:02:55	0:00:27	0:01:32	0:00:34	0:11:36
19	Truck 3	Ricky	10:32:08	10:32:52	10:37:05	10:40:20	10:40:38	10:42:45	10:43:03		10:43:03	0:00:44	0:04:13	0:03:15	0:00:18	0:02:07	0:00:18	0:10:55
20	Truck 4	Kenny	10:40:59	10:41:33	10:43:37	10:46:12	10:46:30	10:48:19	10:48:57		10:48:57	0:00:34	0:02:04	0:02:35	0:00:18	0:01:49	0:00:38	0:07:58
21	Truck 1	Norm	10:44:38	10:45:08	10:49:09	10:52:02	-	-	10:53:36		10:53:36	0:00:30	0:04:01	0:02:53	0:01:34	#VALUE!	#VALUE!	0:08:58
22	Truck 2	Dave	10:49:36	10:50:12	10:54:02	10:56:11	10:56:33	10:59:01	10:59:30		10:59:30	0:00:36	0:03:50	0:02:09	0:00:22	0:02:28	0:00:29	0:09:54
23	Truck 3	Ricky	10:56:55	10:57:30	10:59:54	11:02:36	11:02:50	11:05:04	11:05:21		11:05:21	0:00:35	0:02:24	0:02:42	0:00:14	0:02:14	0:00:17	0:08:26
24	Truck 4	Kenny	11:04:50	11:05:19	11:06:02	11:09:17	11:09:38	11:11:38	11:12:02		11:12:02	0:00:29	0:00:43	0:03:15	0:00:21	0:02:00	0:00:24	0:07:12
25	Truck 1	Norm	11:07:00	11:07:40	11:12:31	11:14:46	-	-	11:16:47		11:16:47	0:00:40	0:04:51	0:02:15	0:02:01	#VALUE!	#VALUE!	0:09:47
26	Truck 2	Dave	11:15:55	11:16:36	11:17:17	11:19:24	11:19:43	11:21:18	11:21:51		11:21:51	0:00:41	0:00:41	0:02:07	0:00:19	0:01:35	0:00:33	0:05:56
27	Truck 3	Ricky	11:20:25	11:21:02	11:22:12	11:24:36	11:24:55	11:26:46	11:27:04		11:27:04	0:00:37	0:01:10	0:02:24	0:00:19	0:01:51	0:00:18	0:06:39
28	Truck 4	Kenny	11:27:10	11:27:50	11:28:30	11:37:07	11:37:48	11:41:20	11:41:44		11:41:44	0:00:40	0:00:40	0:08:37	0:00:41	0:03:32	0:00:24	0:14:34
29	Truck 1	Norm	11:30:58	11:31:37	11:42:09	11:43:30	-	-	11:46:00		11:46:00	0:00:39	0:10:32	0:01:21	0:02:30	#VALUE!	#VALUE!	0:15:02
30	Truck 2	Dave	11:36:25	11:37:03	11:46:20	11:47:55	11:48:16	11:51:10	11:51:43		11:51:43	0:00:38	0:09:17	0:01:35	0:00:21	0:02:54	0:00:33	0:15:18
31	Truck 3	Ricky	11:47:21	11:48:13	11:52:07	11:54:13	11:54:36	11:56:57	11:57:12		11:57:12	0:00:52	0:03:54	0:02:06	0:00:23	0:02:21	0:00:15	0:09:51
32	Truck 4	Norm	12:02:26	12:02:58	12:03:36	12:04:07	-	-	12:05:51		12:05:51	0:00:32	0:00:38	0:00:31	0:01:44	#VALUE!	#VALUE!	0:03:25
33	Truck 1	Ricky	12:11:47	12:12:24	12:13:06	12:13:45	12:14:03	12:15:53	12:16:12		12:16:12	0:00:37	0:00:42	0:00:39	0:00:18	0:01:50	0:00:19	0:04:25
34	Truck 2	Ricky	12:29:05	12:29:44	12:30:18	12:30:45	12:31:03	12:33:41	12:33:57		12:33:57	0:00:39	0:00:34	0:00:27	0:00:18	0:02:38	0:00:16	0:04:52
35	Truck 3	Kenny	12:43:59	12:44:41	12:45:12	12:45:37	12:45:54	12:48:05	12:48:27		12:48:27	0:00:42	0:00:31	0:00:25	0:00:17	0:02:11	0:00:22	0:04:28
36	Truck 4	Ricky	12:48:52	12:49:24	12:49:59	12:51:00	12:51:18	12:52:44	12:53:02		12:53:02	0:00:32	0:00:35	0:01:01	0:00:18	0:01:26	0:00:18	0:04:10
37	Truck 1	Norm	12:52:43	12:53:22	12:54:05	13:03:43	-	-	13:05:30		13:05:30	0:00:39	0:00:43	0:09:38	0:01:47	#VALUE!	#VALUE!	0:12:47
38	Truck 2	Dave	12:56:47	12:57:13	13:05:57	13:07:38	13:08:09	13:10:27	13:11:02		13:11:02	0:00:26	0:08:44	0:01:41	0:00:31	0:02:18	0:00:35	0:14:15
39	Truck 3	Kenny	13:06:43	13:07:32	13:11:40	13:13:54	13:15:15	13:16:19	13:16:41		13:16:41	0:00:49	0:04:08	0:02:14	0:01:21	0:01:04	0:00:22	0:09:58
40	Truck 4	Ricky	13:12:40	13:13:17	13:17:03	13:19:36	13:19:57	13:22:13	13:22:32		13:22:32	0:00:37	0:03:46	0:02:33	0:00:21	0:02:16	0:00:19	0:09:52
41	Truck 1	Norm	13:18:37	13:19:15	13:23:00	13:26:25	-	-	13:28:00		13:28:00	0:00:38	0:03:45	0:03:25	0:01:35	#VALUE!	#VALUE!	0:09:23
42	Truck 2	Dave	13:26:03	13:26:46	13:28:21	13:31:14	13:31:34	13:34:07	13:34:44		13:34:44	0:00:43	0:01:35	0:02:53	0:00:20	0:02:33	0:00:37	0:08:41
43	Truck 3	Kenny	13:31:27	13:32:06	13:35:19	13:37:29	13:37:50	13:40:20	13:40:43		13:40:43	0:00:39	0:03:13	0:02:10	0:00:21	0:02:30	0:00:23	0:09:16
44	Truck 4	Ricky	13:36:41	13:37:14	13:41:03	13:43:43	13:43:55	13:45:30	13:45:50		13:45:50	0:00:33	0:03:49	0:02:37	0:00:15	0:01:35	0:00:20	0:09:09
45	Truck 1	Norm	13:41:46	13:42:20	13:46:18	13:50:58	-	-	13:53:25		13:53:25	0:00:34	0:03:58	0:04:40	0:02:27	#VALUE!	#VALUE!	0:11:39
46	Truck 2	Dave	13:53:10	13:53:42	13:54:25	13:55:10	13:55:40	13:57:51	13:58:23		13:58:23	0:00:32	0:00:43	0:00:45	0:00:30	0:02:11	0:00:32	0:05:13
47	Truck 3										0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00
48	Truck 4										0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00	0:00:00
										Average	0:00:38	0:02:27	0:02:14	0:00:40	0:02:15	0:00:29	0:08:14
										Maximum	0:00:52	0:10:32	0:09:38	0:02:30	0:03:33	0:02:31	0:15:18
										Minimum	0:00:26	0:00:28	0:00:22	0:00:14	0:01:04	0:00:14	0:03:25

July 17, 2012

Notes: 988 loader used until cycle 17 — Four trucks (3 777; 1 770) from cycles 10 to 14 — Dan on 770 (switch to 777 at cycle 19)
Break between cycles 6 and 7 — Three trucks (3 777) after cycle 14
Three trucks (2 777; 1 770) until cycle 10 — Blast in quarry after cycle 21

	Truck #	Driver	Arrive at Water	Leave Water	Back-in to Dump	First Dump	Wait to Dump	Final Dump	Leave Hopper	End Stamp	Water Time	Wait Time	Back-in to Dump Time	First Dump Time	Wait Dump Time	Final Dump Time	Total Time
1	Truck 1	Ricky	7:52:33	7:53:12	7:53:47	7:54:23	7:54:39	7:56:45	7:57:05	7:57:05	0:00:39	0:00:35	0:00:36	0:00:16	0:02:06	0:00:20	0:04:32
2	Truck 2	Dan	7:57:01	7:57:38	7:58:15	8:00:20	-	-	8:01:21	8:01:21	0:00:37	0:00:37	0:02:05	0:01:01	#VALUE!	#VALUE!	0:04:20
3	Truck 3	Kenny	8:06:49	8:07:30	8:08:06	8:08:36	8:08:55	8:10:17	8:10:42	8:10:42	0:00:41	0:00:36	0:00:30	0:00:19	0:01:22	0:00:25	0:03:53
4	Truck 4	Ricky	8:12:34	8:13:13	8:13:53	8:14:32	8:14:50	8:18:18	8:18:35	8:18:35	0:00:39	0:00:40	0:00:39	0:00:18	0:03:28	0:00:17	0:06:01
5	Truck 1	Dan	8:18:02	8:18:35	8:19:09	8:20:51	-	-	8:21:54	8:21:54	0:00:33	0:00:34	0:01:42	0:01:03	#VALUE!	#VALUE!	0:03:52
6	Truck 2	Kenny	8:26:29	8:26:58	8:27:30	8:27:54	8:28:09	8:29:09	8:29:30	8:29:30	0:00:29	0:00:32	0:00:24	0:00:15	0:01:00	0:00:21	0:03:01
7	Truck 3	Ricky	8:58:30	8:59:00	8:59:30	9:00:00	9:00:20	9:01:50	9:02:05	9:02:05	0:00:30	0:00:30	0:00:30	0:00:20	0:01:30	0:00:15	0:03:35
8	Truck 4	Dan	9:02:00	9:02:40	9:03:07	9:05:20	-	-	9:06:15	9:06:15	0:00:40	0:00:27	0:02:13	0:00:55	#VALUE!	#VALUE!	0:04:15
9	Truck 1	Kenny	9:14:50	9:15:30	9:15:57	9:16:25	9:16:45	9:18:11	9:18:35	9:18:35	0:00:40	0:00:27	0:00:28	0:00:20	0:01:26	0:00:24	0:03:45
10	Truck 2	Norm	9:22:57	9:23:30	9:24:08	9:24:30	9:24:49	9:25:38	9:26:06	9:26:06	0:00:33	0:00:38	0:00:22	0:00:19	0:00:49	0:00:28	0:03:09
11	Truck 3	Ricky	9:30:08	9:30:42	9:31:23	9:31:42	9:31:57	9:36:14	9:36:32	9:36:32	0:00:34	0:00:41	0:00:19	0:00:15	0:04:17	0:00:18	0:06:24
12	Truck 4	Dan	9:35:55	9:36:28	9:37:00	9:41:02	-	-	9:42:08	9:42:08	0:00:33	0:00:32	0:04:02	0:01:06	#VALUE!	#VALUE!	0:06:13
13	Truck 1	Kenny	9:43:58	9:44:40	9:45:15	9:45:43	9:46:04	9:48:06	9:48:30	9:48:30	0:00:42	0:00:35	0:00:28	0:00:21	0:02:02	0:00:24	0:04:32
14	Truck 2	Norm	9:53:43	9:54:16	9:55:00	9:55:20	9:55:55	9:57:55	9:58:30	9:58:30	0:00:33	0:00:44	0:00:20	0:00:35	0:02:00	0:00:35	0:04:47
15	Truck 3	Ricky	9:59:10	9:59:45	10:00:18	10:01:07	10:01:25	10:02:50	10:03:09	10:03:09	0:00:35	0:00:33	0:00:49	0:00:18	0:01:25	0:00:19	0:03:59
16	Truck 4	Dan	10:04:36	10:05:10	10:05:53	10:08:20	-	-	10:09:20	10:09:20	0:00:34	0:00:43	0:02:27	0:01:00	#VALUE!	#VALUE!	0:04:44
17	Truck 1	Kenny	10:13:15	10:13:54	10:14:30	10:15:56	10:16:19	10:19:00	10:19:20	10:19:20	0:00:39	0:00:36	0:01:26	0:00:23	0:02:41	0:00:20	0:06:05
18	Truck 2	Ricky	10:17:40	10:18:17	10:19:47	10:22:54	10:23:12	10:26:40	10:26:57	10:26:57	0:00:37	0:01:30	0:03:07	0:00:18	0:03:28	0:00:17	0:09:17
19	Truck 3	Kenny	10:30:57	10:31:35	10:32:14	10:32:42	10:33:07	10:36:42	10:37:05	10:37:05	0:00:38	0:00:39	0:00:28	0:00:25	0:03:35	0:00:23	0:06:08
20	Truck 4	Ricky	10:39:30	10:40:02	10:40:35	10:40:53	10:41:14	10:42:48	10:43:03	10:43:03	0:00:32	0:00:33	0:00:18	0:00:21	0:01:34	0:00:15	0:03:33
21	Truck 1	Dan	10:43:09	10:43:53	10:44:34	10:46:42	10:47:00	10:49:33	10:50:05	10:50:05	0:00:44	0:00:41	0:02:08	0:00:18	0:02:33	0:00:32	0:06:56
22	Truck 2	Kenny	11:19:45	11:20:20	11:20:50	11:21:32	11:21:52	11:23:27	11:23:50	11:23:50	0:00:35	0:00:30	0:00:42	0:00:20	0:01:35	0:00:23	0:04:05
23	Truck 3	Ricky	11:24:55	11:25:33	11:26:08	11:27:22	11:27:40	11:29:56	11:30:10	11:30:10	0:00:38	0:00:35	0:01:14	0:00:18	0:02:16	0:00:14	0:05:15
24	Truck 4	Dan	11:28:04	11:28:36	11:30:36	11:33:03	11:33:29	11:36:13	11:36:41	11:36:41	0:00:32	0:02:00	0:02:27	0:00:26	0:02:44	0:00:28	0:08:37
25	Truck 1	Kenny	11:36:54	11:37:30	11:38:21	11:39:31	11:39:51	11:42:39	11:43:04	11:43:04	0:00:36	0:00:51	0:01:10	0:00:20	0:02:48	0:00:25	0:06:10
										Average	0:00:36	0:00:42	0:01:14	0:00:28	0:02:14	0:00:22	0:05:05
										Maximum	0:00:44	0:02:00	0:04:02	0:01:06	0:04:17	0:00:35	0:09:17
										Minimum	0:00:29	0:00:27	0:00:18	0:00:15	0:00:49	0:00:14	0:03:01

Appendix E: Load-Haul Fleet Reconfiguration Analyses

Haul Truck Specifications

	Model	Payload Capacity (tons)	Body Capacity (yd^3)	Body Raise Time (sec)	Body Lower Time (sec)	Total Dump Time (sec)	Fuel Tank Size (gal)
2	770	40	32.9	8.1	14.7	22.8	140
3	770G	42.6	33	7.5	10	17.5	140
4	772	56	41	8.1	14.7	22.8	140
5	772G	57.2	40.8	7.5	10	17.5	140
6	773G	67	46.75	10	14	24	210
7	775G	77.5	55.23	10	14	24	210
8	777G	109.6	83.8	15	13	28	210
9							

Loader Specifications

	Model	Payload (tons)	Max Bucket Capacity (yd^3)	Hydraulic Cycle Time (sec)	Fuel Tank Size (gal)
2	966H	-	5.5	9.9	100.4
3	966K	-	12	9.8	101
4	972H	-	6	10.4	100.4
5	972K	-	13	10.3	101
6	980H	-	8	11.5	127
7	980K	-	16	11.4	118.1
8	988H	12.5	10	15.6	188
9	990H	16.5	12	15.9	284
10	992K	24	16	14.9	413
11					

988H Loader Scenarios

	Haul Truck Model	Truck Body Capacity (tons)	Max Bucket Capacity (tons)	Number of Buckets to Fill	Hydraulic Cycle Time (min)	Estimated Load Time (min)	Fixed Travel Time (min)	Fixed Water Time (min)	Fixed Water to Box Time (min)	Fixed Dump Time (min)	Estimated Cylce Time (min)	TPH per Truck	Unit CPH (Truck)	Labor CPH (Truck)	Unit CPH (Loader)
2	770	40	12.5	3.20	0.26	2.41	10	0.5	0.75	0.38	14.04	170.89	$ 40.00	$ 50.00	$ 95.00
3	770G	42.6	12.5	3.41	0.26	2.57	10	0.5	0.75	0.29	14.11	181.12	$ 40.00	$ 50.00	$ 95.00
4	772	56	12.5	4.48	0.26	3.38	10	0.5	0.75	0.38	15.01	223.86	$ 50.00	$ 50.00	$ 95.00
5	772G	57.2	12.5	4.58	0.26	3.45	10	0.5	0.75	0.29	14.99	228.90	$ 50.00	$ 50.00	$ 95.00
6	773G	67	12.5	5.36	0.26	4.04	10	0.5	0.75	0.40	15.69	256.16	$ 70.00	$ 50.00	$ 95.00
7	775G	77.5	12.5	6.20	0.26	4.68	10	0.5	0.75	0.40	16.33	284.81	$ 90.00	$ 50.00	$ 95.00
8	777G	109.6	12.5	8.77	0.26	6.61	10	0.5	0.75	0.47	18.33	358.74	$ 125.00	$ 50.00	$ 95.00
9															
10	Current														

	Labor CPH (Loader)	Total CPH (1 Truck)	Cost per Ton (1 Truck)	Total CPH (2 Trucks)	Cost per Ton (2 Trucks)	Total CPH (3 Trucks)	Cost per Ton (3 Trucks)	Total CPH (4 Trucks)	Cost per Ton (4 Trucks)
	$ 50.00	$ 235.00	$ 1.38	$ 325.00	$ 0.95	$ 415.00	$ 0.81	$ 505.00	$ 0.74
	$ 50.00	$ 235.00	$ 1.30	$ 325.00	$ 0.90	$ 415.00	$ 0.76	$ 505.00	$ 0.70
	$ 50.00	$ 245.00	$ 1.09	$ 345.00	$ 0.77	$ 445.00	$ 0.66	$ 545.00	$ 0.61
	$ 50.00	$ 245.00	$ 1.07	$ 345.00	$ 0.75	$ 445.00	$ 0.65	$ 545.00	$ 0.60
	$ 50.00	$ 265.00	$ 1.03	$ 385.00	$ 0.75	$ 505.00	$ 0.66	$ 625.00	$ 0.61
	$ 50.00	$ 285.00	$ 1.00	$ 425.00	$ 0.75	$ 565.00	$ 0.66	$ 705.00	$ 0.62
	$ 50.00	$ 320.00	$ 0.89	$ 495.00	$ 0.69	$ 670.00	$ 0.62	$ 845.00	$ 0.59
								$ 790.00	$ 0.59

990H Loader Scenarios

	Haul Truck Model	Truck Body Capacity (tons)	Max Bucket Capacity (tons)	Number of Buckets to Fill	Hydraulic Cycle Time (min)	Estimated Load Time (min)	Fixed Travel Time (min)	Fixed Water Time (min)	Fixed Water to Box Time (min)	Fixed Dump Time (min)	Estimated Cylce Time (min)	TPH per Truck	Unit CPH (Truck)	Labor CPH (Truck)	Unit CPH (Loader)
2	770	40	16.5	2.42	0.27	1.83	10	0.5	0.75	0.38	13.46	178.32	$ 40.00	$ 50.00	$ 130.00
3	770G	42.6	16.5	2.58	0.27	1.95	10	0.5	0.75	0.29	13.49	189.48	$ 40.00	$ 50.00	$ 130.00
4	772	56	16.5	3.39	0.27	2.56	10	0.5	0.75	0.38	14.19	236.78	$ 50.00	$ 50.00	$ 130.00
5	772G	57.2	16.5	3.47	0.27	2.62	10	0.5	0.75	0.29	14.16	242.42	$ 50.00	$ 50.00	$ 130.00
6	773G	67	16.5	4.06	0.27	3.06	10	0.5	0.75	0.40	14.71	273.22	$ 70.00	$ 50.00	$ 130.00
7	775G	77.5	16.5	4.70	0.27	3.54	10	0.5	0.75	0.40	15.19	306.05	$ 90.00	$ 50.00	$ 130.00
8	777G	109.6	16.5	6.64	0.27	5.01	10	0.5	0.75	0.47	16.73	393.12	$ 125.00	$ 50.00	$ 130.00
9															
10	Current														

	Labor CPH (Loader)	Total CPH (1 Truck)	Cost per Ton (1 Truck)	Total CPH (2 Trucks)	Cost per Ton (2 Trucks)	Total CPH (3 Trucks)	Cost per Ton (3 Trucks)	Total CPH (4 Trucks)	Cost per Ton (4 Trucks)
	$ 50.00	$ 270.00	$ 1.51	$ 360.00	$ 1.01	$ 450.00	$ 0.84	$ 540.00	$ 0.76
	$ 50.00	$ 270.00	$ 1.42	$ 360.00	$ 0.95	$ 450.00	$ 0.79	$ 540.00	$ 0.71
	$ 50.00	$ 280.00	$ 1.18	$ 380.00	$ 0.80	$ 480.00	$ 0.68	$ 580.00	$ 0.61
	$ 50.00	$ 280.00	$ 1.15	$ 380.00	$ 0.78	$ 480.00	$ 0.66	$ 580.00	$ 0.60
	$ 50.00	$ 300.00	$ 1.10	$ 420.00	$ 0.77	$ 540.00	$ 0.66	$ 660.00	$ 0.60
	$ 50.00	$ 320.00	$ 1.05	$ 460.00	$ 0.75	$ 600.00	$ 0.65	$ 740.00	$ 0.60
	$ 50.00	$ 355.00	$ 0.90	$ 530.00	$ 0.67	$ 705.00	$ 0.60	$ 880.00	$ 0.56
								$ 825.00	$ 0.57

992K Loader Scenarios

	Haul Truck Model	Truck Body Capacity (tons)	Max Bucket Capacity (tons)	Number of Buckets to Fill	Hydraulic Cycle Time (min)	Estimated Load Time (min)	Fixed Travel Time (min)	Fixed Water Time (min)	Fixed Water to Box Time (min)	Fixed Dump Time (min)	Estimated Cylce Time (min)	TPH per Truck	Unit CPH (Truck)	Labor CPH (Truck)	Unit CPH (Loader)
2	770	40	24	1.67	0.25	1.26	10	0.5	0.75	0.38	12.89	186.24	$ 40.00	$ 50.00	$ 170.00
3	770G	42.6	24	1.78	0.25	1.34	10	0.5	0.75	0.29	12.88	198.44	$ 40.00	$ 50.00	$ 170.00
4	772	56	24	2.33	0.25	1.76	10	0.5	0.75	0.38	13.39	250.94	$ 50.00	$ 50.00	$ 170.00
5	772G	57.2	24	2.38	0.25	1.80	10	0.5	0.75	0.29	13.34	257.29	$ 50.00	$ 50.00	$ 170.00
6	773G	67	24	2.79	0.25	2.11	10	0.5	0.75	0.40	13.76	292.25	$ 70.00	$ 50.00	$ 170.00
7	775G	77.5	24	3.23	0.25	2.44	10	0.5	0.75	0.40	14.09	330.13	$ 90.00	$ 50.00	$ 170.00
8	777G	109.6	24	4.57	0.25	3.44	10	0.5	0.75	0.47	15.16	433.76	$ 125.00	$ 50.00	$ 170.00
9															
10	Current														

	Labor CPH (Loader)	Total CPH (1 Truck)	Cost per Ton (1 Truck)	Total CPH (2 Trucks)	Cost per Ton (2 Trucks)	Total CPH (3 Trucks)	Cost per Ton (3 Trucks)	Total CPH (4 Trucks)	Cost per Ton (4 Trucks)
	$ 50.00	$ 310.00	$ 1.66	$ 400.00	$ 1.07	$ 490.00	$ 0.88	$ 580.00	$ 0.78
	$ 50.00	$ 310.00	$ 1.56	$ 400.00	$ 1.01	$ 490.00	$ 0.82	$ 580.00	$ 0.73
	$ 50.00	$ 320.00	$ 1.28	$ 420.00	$ 0.84	$ 520.00	$ 0.69	$ 620.00	$ 0.62
	$ 50.00	$ 320.00	$ 1.24	$ 420.00	$ 0.82	$ 520.00	$ 0.67	$ 620.00	$ 0.60
	$ 50.00	$ 340.00	$ 1.16	$ 460.00	$ 0.79	$ 580.00	$ 0.66	$ 700.00	$ 0.60
	$ 50.00	$ 360.00	$ 1.09	$ 500.00	$ 0.76	$ 640.00	$ 0.65	$ 780.00	$ 0.59
	$ 50.00	$ 395.00	$ 0.91	$ 570.00	$ 0.66	$ 745.00	$ 0.57	$ 920.00	$ 0.53
								$ 865.00	$ 0.54

Appendix F: PEAK System Primary Crusher Data

OPS Plant Stage KPI Report

PEAK Fiscal Months: 01/09 - 12/12

00620 620: Lunenburg

Stage: 21.1-PRI-1-Primary OEE Target: 85% Availability Target: 92%

ID	Mode	Date	Shift	Sched. Down Hrs.	Sched. Hours	Down-time Hours	Av. Hours	Units Produced	Theoretical Produced	OEE	Availability	TPSH	TPAH	Speed Loss
384160	11111	11/16/2012	1st Shift	1.00	8.00	4.67	2.33	1,205	6,400	19%	29.1%	151	517	0.82
383534	11111	11/15/2012	1st Shift	0.50	10.00	1.20	8.30	6,500	8,000	81%	83.0%	650	783	0.18
383260	10011	11/14/2012	1st Shift	* 1.25	10.00	0.83	7.92	6,100	8,000	76%	79.2%	610	770	0.3
382959	10011	11/13/2012	1st Shift	0.83	10.00	1.17	8.00	5,500	8,000	69%	80.0%	550	688	1.13
382583	11111	11/12/2012	1st Shift	* 1.42	10.00	0.50	8.08	6,100	8,000	76%	80.8%	610	755	0.46
382089	10001	11/9/2012	1st Shift	* 1.08	10.00	0.93	7.99	6,100	8,000	76%	79.9%	610	763	0.37
381549	10001	11/8/2012	1st Shift	* 8.00	8.00	0.00	0.00	0	6,400	0%	0.0%	0	0	0
381129	10001	11/7/2012	1st Shift	0.92	10.00	3.83	5.25	3,000	8,000	38%	52.5%	300	571	1.5
380904	10001	11/6/2012	1st Shift	0.67	10.00	3.75	5.58	2,300	8,000	29%	55.8%	230	412	2.71
380505	10001	11/5/2012	1st Shift	0.00	8.00	5.58	2.42	1,100	6,400	17%	30.3%	138	455	1.05
380021	10001	11/2/2012	1st Shift	0.00	9.00	6.30	2.70	2,100	7,200	29%	30.0%	233	778	0.08
379210	10011	10/31/2012	1st Shift	0.00	9.50	5.92	3.58	2,800	7,600	37%	37.7%	295	782	0.08
378040	10011	10/26/2012	1st Shift	0.75	9.50	1.80	6.95	5,000	7,600	66%	73.2%	526	719	0.7
377447	10011	10/25/2012	1st Shift	1.00	9.50	0.25	8.25	6,200	7,600	82%	86.8%	653	752	0.5
376951	10010	10/24/2012	1st Shift	0.92	11.00	0.70	9.38	7,700	8,800	87%	85.3%	700	821	-0.24
376670	10011	10/23/2012	1st Shift	0.92	11.00	1.52	8.56	7,200	8,800	82%	77.8%	655	841	-0.44
376144	10011	10/22/2012	1st Shift	1.00	10.00	4.37	4.63	3,600	8,000	45%	46.3%	360	778	0.13
375750	10011	10/19/2012	1st Shift	* 1.25	10.00	1.58	7.17	6,200	8,000	78%	71.7%	620	865	-0.58
375000	10011	10/18/2012	1st Shift	0.50	11.00	1.25	9.25	7,000	8,800	80%	84.1%	636	757	0.5
374755	10010	10/17/2012	1st Shift	0.00	11.00	5.00	6.00	4,900	8,800	56%	54.5%	445	817	-0.13
374124	10011	10/16/2012	1st Shift	0.67	10.00	1.47	7.86	6,200	8,000	78%	78.6%	620	789	0.11
373575	10011	10/15/2012	1st Shift	0.58	11.00	0.93	9.49	7,600	8,800	86%	86.3%	691	801	-0.01
373204	10011	10/12/2012	1st Shift	1.00	10.00	3.58	5.42	4,500	8,000	56%	54.2%	450	830	-0.21
372661	10011	10/11/2012	1st Shift	0.42	11.00	0.53	10.05	8,500	8,800	97%	91.4%	773	846	-0.57
372303	10011	10/10/2012	1st Shift	0.50	10.00	4.25	5.25	4,200	8,000	53%	52.5%	420	800	0
371820	10011	10/9/2012	1st Shift	0.33	8.00	0.25	7.42	5,800	6,400	91%	92.8%	725	782	0.17
371186	10010	10/8/2012	1st Shift	0.50	11.00	0.25	10.25	8,500	8,800	97%	93.2%	773	829	-0.37
370890	10011	10/5/2012	1st Shift	0.83	10.00	5.92	3.25	2,100	8,000	26%	32.5%	210	646	0.63
370321	10011	10/4/2012	1st Shift	0.00	8.00	5.75	2.25	1,000	6,400	16%	28.1%	125	444	1
369916	10011	10/3/2012	1st Shift	0.50	10.00	0.70	8.80	5,100	8,000	64%	88.0%	510	580	2.43
369396	10011	10/2/2012	1st Shift	0.92	10.00	0.33	8.75	5,200	8,000	65%	87.5%	520	594	2.25
368684	10010	10/1/2012	1st Shift	* 1.75	10.00	0.67	7.58	4,700	8,000	59%	75.8%	470	620	1.71
368439	10010	9/28/2012	1st Shift	* 1.33	10.00	3.92	4.75	4,600	8,000	58%	47.5%	460	968	-1
367647	10010	9/27/2012	1st Shift	* 1.33	11.00	2.42	7.25	4,900	8,800	56%	65.9%	445	676	1.12
367318	10001	9/26/2012	1st Shift	0.50	8.00	0.50	7.00	5,200	6,400	81%	87.5%	650	743	0.5
366853	10000	9/25/2012	1st Shift	0.50	10.00	5.92	3.58	2,300	8,000	29%	35.8%	230	642	0.71
366333	10000	9/24/2012	1st Shift	* 1.12	10.00	3.25	5.63	4,200	8,000	53%	56.3%	420	746	0.38
365908	10000	9/22/2012	1st Shift	0.67	8.00	0.33	7.00	5,500	6,400	86%	87.5%	688	786	0.13
365900	10000	9/21/2012	1st Shift	* 1.75	10.00	1.58	6.67	4,900	8,000	61%	66.7%	490	735	0.55
365888	10000	9/20/2012	1st Shift	0.58	10.00	1.33	8.09	5,500	8,000	69%	80.9%	550	680	1.22
364611	10001	9/19/2012	1st Shift	* 1.08	11.00	1.67	8.25	6,400	8,800	73%	75.0%	582	776	0.25

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Theoretical Produced = ([Sched. Hours] * [MaxObsCapacity]) | Availability = ([Available Hours] / [Sched. Hours]) | Speed Loss = (([Theoretical Produced]*[Availability]-[TonsProduced])/[MaxObsCapacity]) | OEE = [Units Produced]/[Theoretical Produced]

Sched. Downtime > 1 Hr.

Stage: 21.1-PRI-1-Primary   OEE Target: 85%   Availability Target: 92%

ID	Mode	Date	Shift	Sched. Down Hrs.	Sched. Hours	Down-time Hours	Av. Hours	Units Produced	Theoretical Produced	OEE	Availability	TPSH	TPAH	Speed Loss
364199	10000	9/18/2012	1st Shift	0.00	11.00	5.67	5.33	4,000	8,800	45%	48.5%	364	750	0.34
363650	10000	9/17/2012	1st Shift	0.75	10.00	1.75	7.50	5,800	8,000	73%	75.0%	580	773	0.25
363217	10000	9/15/2012	1st Shift	0.50	8.00	0.58	6.92	3,700	6,400	58%	86.5%	463	535	2.3
362997	10000	9/14/2012	1st Shift	* 8.00	8.00	0.00	0.00	0	6,400	0%	0.0%	0	0	0
362995	10000	9/13/2012	1st Shift	*10.00	10.00	0.00	0.00	0	8,000	0%	0.0%	0	0	0
362219	10001	9/12/2012	1st Shift	0.67	10.00	2.98	6.35	4,000	8,000	50%	63.5%	400	630	1.35
361603	10000	9/11/2012	1st Shift	0.00	10.00	0.25	9.75	5,000	8,000	63%	97.5%	500	513	3.5
361122	10000	9/10/2012	1st Shift	* 1.75	10.00	0.42	7.83	5,500	8,000	69%	78.3%	550	702	0.96
360704	10000	9/8/2012	1st Shift	0.33	6.00	0.17	5.50	2,500	4,800	52%	91.7%	417	455	2.38
360702	10000	9/7/2012	1st Shift	0.58	10.00	4.08	5.34	3,000	8,000	38%	53.4%	300	562	1.59
360154	10001	9/6/2012	1st Shift	0.00	8.00	6.67	1.33	800	6,400	13%	16.6%	100	602	0.33
359619	10000	9/5/2012	1st Shift	* 1.08	10.00	1.25	7.67	5,400	8,000	68%	76.7%	540	704	0.92
359237	10000	9/4/2012	1st Shift	* 1.33	10.00	1.75	6.92	4,800	8,000	60%	69.2%	480	694	0.92
358674	10000	8/31/2012	1st Shift	* 1.42	9.00	1.00	6.58	4,000	7,200	56%	73.1%	444	608	1.58
358688	10000	8/30/2012	1st Shift	* 8.00	8.00	0.00	0.00	0	6,400	0%	0.0%	0	0	0
358629	10001	8/29/2012	1st Shift	0.50	10.00	1.75	7.75	4,400	8,000	55%	77.5%	440	568	2.25
357187	10001	8/28/2012	1st Shift	* 1.38	10.00	1.02	7.60	5,700	8,000	71%	76.0%	570	750	0.48
356564	10001	8/27/2012	1st Shift	* 1.25	10.00	1.08	7.67	5,800	8,000	73%	76.7%	580	756	0.42
356238	10001	8/25/2012	1st Shift	0.42	6.00	0.67	4.91	3,200	4,800	67%	81.8%	533	652	0.91
356225	10000	8/24/2012	1st Shift	0.67	10.00	5.33	4.00	2,600	8,000	33%	40.0%	260	650	0.75
355418	10000	8/23/2012	1st Shift	0.50	8.00	4.25	3.25	2,500	6,400	39%	40.6%	313	769	0.12
355002	10000	8/22/2012	1st Shift	0.50	10.00	0.45	9.05	6,900	8,000	86%	90.5%	690	762	0.43
355035	10000	8/21/2012	1st Shift	* 2.42	8.00	0.67	4.91	3,500	6,400	55%	61.4%	438	713	0.54
355012	10001	8/20/2012	1st Shift	0.75	10.00	0.33	8.92	6,900	8,000	86%	89.2%	690	774	0.3
353497	10001	8/17/2012	1st Shift	1.00	10.00	2.67	6.33	3,600	8,000	45%	63.3%	360	569	1.83
352522	10001	8/16/2012	1st Shift	0.33	10.00	0.42	9.25	7,100	8,000	89%	92.5%	710	768	0.38
352037	10001	8/15/2012	1st Shift	0.00	10.00	3.58	6.42	5,000	8,000	63%	64.2%	500	779	0.17
351500	10001	8/14/2012	1st Shift	1.00	8.00	2.50	4.50	3,300	6,400	52%	56.3%	413	733	0.38
351190	10001	8/13/2012	1st Shift	0.50	8.00	1.25	6.25	4,500	6,400	70%	78.1%	563	720	0.62
350479	10000	8/10/2012	1st Shift	* 1.25	8.50	0.33	6.92	5,500	6,800	81%	81.4%	647	795	0.04
350131	10000	8/9/2012	1st Shift	0.42	10.00	0.87	8.71	6,800	8,000	85%	87.1%	680	781	0.21
349489	10000	8/8/2012	1st Shift	0.42	8.00	0.60	6.98	5,900	6,400	92%	87.3%	738	845	-0.39
349035	10101	8/7/2012	1st Shift	0.00	10.00	5.75	4.25	3,700	8,000	46%	42.5%	370	871	-0.38
348377	10001	8/6/2012	1st Shift	0.50	9.00	1.17	7.33	5,500	7,200	76%	81.4%	611	750	0.45
348061	10000	8/3/2012	1st Shift	0.00	9.00	0.60	8.40	3,700	7,200	51%	93.3%	411	440	3.77
347481	10000	8/2/2012	1st Shift	* 8.00	8.00	0.00	0.00	0	6,400	0%	0.0%	0	0	0
346931	10000	8/1/2012	1st Shift	0.42	10.00	1.33	8.25	5,700	8,000	71%	82.5%	570	691	1.13
346546	10000	7/31/2012	1st Shift	* 1.25	10.00	0.33	8.42	6,500	8,000	81%	84.2%	650	772	0.3
345866	10000	7/30/2012	1st Shift	* 1.17	10.00	3.42	5.41	4,000	8,000	50%	54.1%	400	739	0.41
344742	10000	7/27/2012	1st Shift	0.00	8.00	8.00	0.00	0	6,400	0%	0.0%	0	0	0
344376	10000	7/26/2012	1st Shift	0.50	8.00	2.75	4.75	3,900	6,400	61%	59.4%	488	821	-0.12
343707	10000	7/25/2012	1st Shift	0.33	8.00	1.92	5.75	2,800	6,400	44%	71.9%	350	487	2.25
343162	10001	7/24/2012	1st Shift	* 1.08	10.00	1.32	7.60	5,200	8,000	65%	76.0%	520	684	1.1
342884	10001	7/23/2012	1st Shift	0.50	10.00	0.58	8.92	6,268	8,000	78%	89.2%	627	703	1.09
342421	10001	7/20/2012	1st Shift	* 1.25	10.00	1.17	7.58	6,010	8,000	75%	75.8%	601	793	0.07
341782	10000	7/19/2012	1st Shift	0.00	4.00	0.58	3.42	3,300	3,200	103%	85.5%	825	965	-0.71

Theoretical Produced = ([Sched. Hours] * [MaxObsCapacity]) | Availability = ([Available Hours] / [Sched. Hours]) | Speed Loss = ((([Theoretical Produced]*[Availability])-[TonsProduced])/[MaxObsCapacity]) | OEE = [Units Produced]/[Theoretical Produced]

* Sched. Downtime > 1 Hr.

Stage: 21.1-PRI-1-Primary   **OEE Target:** 85%   **Availability Target:** 92%

ID	Mode	Date	Shift	Sched. Down Hrs.	Sched. Hours	Down-time Hours	Av. Hours	Units Produced	Theoretical Produced	OEE	Availability	TPSH	TPAH	Speed Loss
34147	10000	7/18/2012	1st Shift	0.50	9.00	0.78	7.72	6,200	7,200	86%	85.8%	689	803	-0.03
34078	10001	7/17/2012	1st Shift	1.00	9.00	1.50	6.50	5,400	7,200	75%	72.2%	600	831	-0.25
34018	10000	7/16/2012	1st Shift	0.42	10.00	0.33	9.25	8,110	8,000	101%	92.5%	811	877	-0.89
33981	10000	7/13/2012	1st Shift	* 2.25	10.00	1.08	6.67	5,410	8,000	68%	66.7%	541	811	-0.09
33908	10000	7/12/2012	1st Shift	0.42	10.00	0.50	9.08	7,510	8,000	94%	90.8%	751	827	-0.31
33908	10000	7/11/2012	1st Shift	* 8.00	8.00	0.00	0.00	0	6,400	0%	0.0%	0	0	0
33789	10000	7/10/2012	1st Shift	0.42	8.00	5.25	2.33	1,800	6,400	28%	29.1%	225	773	0.08
33764	10000	7/9/2012	1st Shift	0.58	8.00	5.83	1.59	1,400	6,400	22%	19.9%	175	881	-0.16
33685	10000	7/6/2012	1st Shift	* 1.17	8.00	1.02	5.81	3,700	6,400	58%	72.6%	463	637	1.18
33670	10001	7/5/2012	1st Shift	0.50	10.00	0.53	8.97	5,900	8,000	74%	89.7%	590	658	1.6
33632	10000	7/3/2012	1st Shift	0.33	7.00	0.58	6.09	3,800	5,600	68%	87.0%	543	624	1.34
33592	10010	7/2/2012	1st Shift	* 1.33	10.00	0.78	7.89	6,000	8,000	75%	78.9%	600	760	0.39
33553	10011	6/29/2012	1st Shift	* 1.17	10.00	0.50	8.33	7,600	8,000	95%	83.3%	760	912	-1.17
33468	10001	6/28/2012	1st Shift	* 1.33	10.00	0.50	8.17	6,300	8,000	79%	81.7%	630	771	0.3
33433	10000	6/27/2012	1st Shift	0.25	10.00	1.50	8.25	5,800	8,000	73%	82.5%	580	703	1
33365	10001	6/26/2012	1st Shift	* 1.58	10.00	1.77	6.65	5,000	8,000	63%	66.5%	500	752	0.4
33319	10001	6/25/2012	1st Shift	0.75	10.00	2.63	6.62	5,100	8,000	64%	66.2%	510	770	0.25
33241	10010	6/22/2012	1st Shift	* 2.08	8.00	0.80	5.12	4,300	6,400	67%	64.0%	538	840	-0.26
33193	10001	6/21/2012	1st Shift	* 1.08	8.00	1.42	5.50	4,900	6,400	77%	68.8%	613	891	-0.62
33163	10000	6/20/2012	1st Shift	* 1.42	10.00	1.83	6.75	6,200	8,000	78%	67.5%	620	919	-1
33104	10000	6/19/2012	1st Shift	* 1.08	10.00	0.83	8.09	6,700	8,000	84%	80.9%	670	828	-0.29
33058	10000	6/18/2012	1st Shift	0.50	10.00	0.92	8.58	7,600	8,000	95%	85.8%	760	886	-0.92
33008	10000	6/16/2012	1st Shift	0.25	8.00	0.75	7.00	5,000	6,400	78%	87.5%	625	714	0.75
33008	10000	6/15/2012	1st Shift	* 8.00	8.00	0.00	0.00	0	6,400	0%	0.0%	0	0	0
32950	10000	6/14/2012	1st Shift	* 5.75	10.00	0.58	3.67	2,500	8,000	31%	36.7%	250	681	0.55
32949	10000	6/13/2012	1st Shift	0.50	10.00	4.75	4.75	3,200	8,000	40%	47.5%	320	674	0.75
32833	10000	6/12/2012	1st Shift	0.00	10.00	5.33	4.67	2,900	8,000	36%	46.7%	290	621	1.05
32811	10000	6/11/2012	1st Shift	0.00	10.00	1.08	8.92	6,200	8,000	78%	89.2%	620	695	1.17
32736	10000	6/8/2012	1st Shift	0.75	11.00	0.50	9.75	5,700	8,800	65%	88.6%	518	585	2.62
32711	10000	6/7/2012	1st Shift	0.00	10.00	0.00	10.00	6,100	8,000	76%	100.0%	610	610	2.38
32636	10000	6/6/2012	1st Shift	0.58	10.00	0.50	8.92	6,300	8,000	79%	89.2%	630	706	1.05
32584	10000	6/5/2012	1st Shift	0.83	10.00	0.92	8.25	5,900	8,000	74%	82.5%	590	715	0.88
32561	10000	6/4/2012	1st Shift	0.50	10.00	1.25	8.25	6,100	8,000	76%	82.5%	610	739	0.63
32479	10000	6/1/2012	1st Shift	* 1.75	10.00	1.08	7.17	5,800	8,000	73%	71.7%	580	809	-0.08
32429	10000	5/31/2012	1st Shift	0.58	10.00	0.42	9.00	6,600	8,000	83%	90.0%	660	733	0.75
32372	10000	5/30/2012	1st Shift	0.75	10.00	0.42	8.83	6,900	8,000	86%	88.3%	690	781	0.21
32332	10000	5/29/2012	1st Shift	0.33	10.00	1.75	7.92	6,000	8,000	75%	79.2%	600	758	0.42
32285	10000	5/25/2012	1st Shift	* 1.17	8.00	0.50	6.33	3,700	6,400	58%	79.1%	463	585	1.7
32263	10000	5/24/2012	1st Shift	0.00	10.00	7.08	2.92	1,700	8,000	21%	29.2%	170	582	0.8
32191	10000	5/23/2012	1st Shift	0.50	10.00	4.75	4.75	3,200	8,000	40%	47.5%	320	674	0.75
32150	10000	5/22/2012	1st Shift	0.67	10.00	1.08	8.25	6,100	8,000	76%	82.5%	610	739	0.63
32100	10001	5/21/2012	1st Shift	0.58	10.00	1.17	8.25	6,100	8,000	76%	82.5%	610	739	0.63
32086	10000	5/19/2012	1st Shift	* 6.00	6.00	0.00	0.00	0	4,800	0%	0.0%	0	0	0
32041	10000	5/18/2012	1st Shift	1.00	10.00	0.42	8.58	6,200	8,000	78%	85.8%	620	723	0.83
32001	10000	5/17/2012	1st Shift	0.58	10.00	3.67	5.75	4,300	8,000	54%	57.5%	430	748	0.38
31942	10001	5/16/2012	1st Shift	* 1.17	10.00	0.83	8.00	5,500	8,000	69%	80.0%	550	688	1.13

Theoretical Produced = ([Sched. Hours] * [MaxObsCapacity]) | Availability = ([Available Hours] / [Sched. Hours]) | Speed Loss = ((([Theoretical Produced]*[Availability])-[TonsProduced])/[MaxObsCapacity]) | OEE = [Units Produced]/[Theoretical Produced]

* Sched. Downtime > 1 Hr.

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Stage:	21.1-PRI-1-Primary									OEE Target: 85%	Availability Target: 92%			
ID	Mode	Date	Shift	Sched. Down Hrs.	Sched. Hours	Down-time Hours	Av. Hours	Units Produced	Theoretical Produced	OEE	Availability	TPSH	TPAH	Speed Loss
319419	10001	5/15/2012	1st Shift	* 1.25	10.00	1.08	7.67	5,900	8,000	74%	76.7%	590	769	0.3
318519	10001	5/14/2012	1st Shift	* 1.30	10.00	0.42	8.28	5,000	8,000	63%	82.8%	500	604	2.03
318279	10000	5/12/2012	1st Shift	0.42	8.00	0.33	7.25	3,685	6,400	58%	90.6%	461	508	2.64
318273	10001	5/11/2012	1st Shift	* 1.25	8.00	1.50	5.25	4,200	6,400	66%	65.6%	525	800	0
317553	10001	5/10/2012	1st Shift	* 1.42	8.00	0.50	6.08	4,100	6,400	64%	76.0%	513	674	0.96
316953	10000	5/9/2012	1st Shift	0.50	8.00	0.67	6.83	4,400	6,400	69%	85.4%	550	644	1.33
316504	10011	5/8/2012	1st Shift	0.50	8.00	0.42	7.08	4,300	6,400	67%	88.5%	538	607	1.71
316084	10000	5/7/2012	1st Shift	0.00	8.00	6.50	1.50	900	6,400	14%	18.8%	113	600	0.38
315558	10000	5/5/2012	1st Shift	0.42	8.00	1.33	6.25	3,700	6,400	58%	78.1%	463	592	1.62
315550	10001	5/4/2012	1st Shift	1.00	8.00	0.75	6.25	3,900	6,400	61%	78.1%	488	624	1.37
314929	10001	5/3/2012	1st Shift	0.33	8.00	0.33	7.34	4,200	6,400	66%	91.8%	525	572	2.09
314509	10000	5/2/2012	1st Shift	0.00	8.00	3.08	4.92	2,900	6,400	45%	61.5%	363	589	1.3
314284	10000	5/1/2012	1st Shift	0.50	8.00	1.25	6.25	4,200	6,400	66%	78.1%	525	672	1
313690	10000	4/30/2012	1st Shift	0.58	8.00	0.92	6.50	4,100	6,400	64%	81.3%	513	631	1.38
313330	10000	4/27/2012	1st Shift	* 1.50	8.00	0.25	6.25	4,300	6,400	67%	78.1%	538	688	0.87
312701	10000	4/26/2012	1st Shift	0.58	8.00	0.33	7.09	3,700	6,400	58%	88.6%	463	522	2.46
312178	10000	4/25/2012	1st Shift	0.92	8.00	3.67	3.41	2,300	6,400	36%	42.6%	288	674	0.53
311887	10010	4/24/2012	1st Shift	0.33	8.00	0.33	7.34	3,900	6,400	61%	91.8%	488	531	2.47
311229	10010	4/23/2012	1st Shift	0.00	8.00	5.67	2.33	1,400	6,400	22%	29.1%	175	601	0.58
311139	10010	4/20/2012	1st Shift	* 1.08	8.00	0.08	6.84	4,700	6,400	73%	85.5%	588	687	0.97
311136	10010	4/19/2012	1st Shift	0.42	10.00	0.50	9.08	6,600	8,000	83%	90.8%	660	727	0.83
309960	10011	4/18/2012	1st Shift	0.00	8.00	8.00	0.00	0	6,400	0%	0.0%	0	0	0
309590	10011	4/17/2012	1st Shift	0.67	8.00	1.03	6.30	4,800	6,400	75%	78.8%	600	762	0.3
309211	10011	4/16/2012	1st Shift	0.50	8.00	0.70	6.80	4,600	6,400	72%	85.0%	575	676	1.05
309050	10011	4/13/2012	1st Shift	* 1.75	8.00	1.50	4.75	3,500	6,400	55%	59.4%	438	737	0.38
309049	10011	4/12/2012	1st Shift	0.50	8.00	3.50	4.00	2,800	6,400	44%	50.0%	350	700	0.5
309048	10011	4/11/2012	1st Shift	0.00	8.00	2.58	5.42	3,600	6,400	56%	67.8%	450	664	0.92
309047	10011	4/10/2012	1st Shift	0.42	8.00	1.25	6.33	3,700	6,400	58%	79.1%	463	585	1.7
309045	10001	4/9/2012	1st Shift	0.42	8.00	3.35	4.23	2,600	6,400	41%	52.9%	325	615	0.98
290503	9111	12/12/2011	1st Shift	0.00	8.00	0.50	7.50	109	7,264	2%	93.8%	14	15	7.38
290491	9112	12/9/2011	1st Shift	0.33	3.50	2.42	0.75	931	3,623	26%	21.4%	266	1,241	-0.15
289529	9112	12/8/2011	1st Shift	1.00	9.00	4.75	3.25	2,504	9,315	27%	36.1%	278	770	0.83
289244	9112	12/7/2011	1st Shift	0.42	9.00	5.92	2.66	1,623	9,315	17%	29.6%	180	610	1.1
288989	9112	12/6/2011	1st Shift	0.42	9.50	0.42	8.66	6,307	9,833	64%	91.2%	664	728	2.57
288628	9111	12/5/2011	1st Shift	0.33	9.00	0.08	8.59	7,841	8,172	96%	95.4%	871	913	-0.05
288400	9111	12/2/2011	1st Shift	1.00	9.00	0.25	7.75	6,666	8,172	82%	86.1%	741	860	0.41
288001	9112	12/1/2011	1st Shift	0.33	7.00	0.08	6.59	5,100	7,245	70%	94.1%	729	774	1.66
287651	9112	11/30/2011	1st Shift	0.33	9.67	0.75	8.59	6,933	10,008	69%	88.8%	717	807	1.89
287366	9111	11/29/2011	1st Shift	0.33	9.17	0.17	8.67	7,515	8,326	90%	94.5%	820	867	0.39
287007	9112	11/28/2011	1st Shift	0.33	9.50	0.33	8.84	7,456	9,833	76%	93.1%	785	843	1.64
285697	9112	11/18/2011	1st Shift	0.67	8.50	2.00	5.83	5,092	8,798	58%	68.6%	599	873	0.91
285411	9112	11/17/2011	1st Shift	* 2.08	8.50	0.83	5.59	5,206	8,798	59%	65.8%	612	931	0.56
279514	9111	10/29/2011	1st Shift	0.00	7.00	0.17	6.83	4,677	6,356	74%	97.6%	668	685	1.68
279508	9111	10/28/2011	1st Shift	0.00	10.00	0.07	9.93	5,190	9,080	57%	99.3%	519	523	4.21
278669	9111	10/27/2011	1st Shift	0.42	10.00	0.58	9.00	7,938	9,080	87%	90.0%	794	882	0.26
278230	9111	10/26/2011	1st Shift	0.00	10.00	4.32	5.68	4,533	9,080	50%	56.8%	453	798	0.69

Theoretical Produced = ([Sched. Hours] * [MaxObsCapacity]) | Availability = ([Available Hours] / [Sched. Hours]) | Speed Loss = ((([Theoretical Produced]*[Availability])- [TonsProduced])/[MaxObsCapacity]) | OEE = [Units Produced]/[Theoretical Produced]

* Sched. Downtime > 1 Hr.

ID	Mode	Date	Shift	Sched. Down Hrs.	Sched. Hours	Down-time Hours	Av. Hours	Units Produced	Theoretical Produced	OEE	Availability	TPSH	TPAH	Speed Loss
277735	9112	10/25/2011	1st Shift	0.50	8.00	0.00	7.50	6,372	8,280	77%	93.8%	797	850	1.35
277382	9112	10/24/2011	1st Shift	0.92	10.50	3.25	6.33	4,818	10,868	44%	60.3%	459	761	1.68
276874	9112	10/22/2011	1st Shift	0.33	9.00	1.42	7.25	6,014	9,315	65%	80.6%	668	830	1.44
276858	9112	10/21/2011	1st Shift	1.00	8.00	0.67	6.33	5,822	8,280	70%	79.1%	728	920	0.7
276432	9112	10/20/2011	1st Shift	0.42	9.50	0.08	9.00	7,447	9,833	76%	94.7%	784	827	1.8
275828	9111	10/19/2011	1st Shift	0.58	9.50	3.58	5.34	4,584	8,626	53%	56.2%	483	858	0.29
275479	9111	10/18/2011	1st Shift	0.42	9.50	0.50	8.58	7,150	8,626	83%	90.3%	753	833	0.7
275102	9111	10/17/2011	1st Shift	* 1.17	9.50	0.08	8.25	7,150	8,626	83%	86.8%	753	867	0.37
274493	9111	10/15/2011	1st Shift	0.33	8.50	0.92	7.25	4,211	7,718	55%	85.3%	495	581	2.61
274497	9111	10/14/2011	1st Shift	0.42	8.50	0.08	8.00	6,766	7,718	88%	94.1%	796	846	0.55
274099	9111	10/13/2011	1st Shift	0.83	9.50	1.00	7.67	5,868	8,626	68%	80.7%	618	765	1.2
273631	9111	10/12/2011	1st Shift	0.33	9.00	2.92	5.75	4,767	8,172	58%	63.9%	530	829	0.5
273072	9111	10/11/2011	1st Shift	0.50	9.00	0.58	7.92	4,717	8,172	58%	88.0%	524	596	2.73
272839	9111	10/10/2011	1st Shift	0.33	9.50	4.25	4.92	4,576	8,626	53%	51.8%	482	930	-0.12
272369	9112	10/8/2011	1st Shift	0.42	7.50	0.08	7.00	5,701	7,763	73%	93.3%	760	814	1.49
272153	9112	10/7/2011	1st Shift	0.42	9.00	1.42	7.16	5,254	9,315	56%	79.6%	584	734	2.09
271704	9112	10/6/2011	1st Shift	0.83	9.00	0.50	7.67	5,610	9,315	60%	85.2%	623	731	2.25
271414	9112	10/5/2011	1st Shift	0.42	9.00	1.75	6.83	5,502	9,315	59%	75.9%	611	806	1.52
270933	9112	10/4/2011	1st Shift	0.00	9.00	7.92	1.08	811	9,315	9%	12.0%	90	751	0.3
270504	9111	10/3/2011	1st Shift	* 1.83	9.00	0.17	7.00	5,610	8,172	69%	77.8%	623	801	0.82
270089	9112	10/1/2011	1st Shift	0.25	8.00	0.17	7.58	4,526	8,280	55%	94.8%	566	597	3.21
269910	9112	9/30/2011	1st Shift	0.42	9.00	3.75	4.83	3,835	9,315	41%	53.7%	426	794	1.13
269554	9115	9/29/2011	1st Shift	0.33	8.00	0.17	7.50	5,249	6,416	82%	93.8%	656	700	0.96
269009	9115	9/28/2011	1st Shift	0.42	9.00	2.42	6.16	5,190	7,218	72%	68.4%	577	843	-0.32
268664	9111	9/27/2011	1st Shift	0.50	9.00	0.17	8.33	6,820	8,172	83%	92.6%	758	819	0.82
268272	9112	9/26/2011	1st Shift	0.00	9.00	4.67	4.33	2,936	9,315	32%	48.1%	326	678	1.49
267770	9116	9/23/2011	1st Shift	* 1.67	9.00	0.25	7.08	5,720	7,308	78%	78.7%	636	808	0.04
267239	9116	9/22/2011	1st Shift	0.50	9.00	0.92	7.58	6,380	7,308	87%	84.2%	709	842	-0.28
266833	9112	9/21/2011	1st Shift	* 1.25	9.00	0.42	7.33	5,830	9,315	63%	81.4%	648	795	1.69
266291	9112	9/20/2011	1st Shift	* 3.00	9.00	0.67	5.33	3,968	9,315	43%	59.2%	441	744	1.49
265794	9112	9/19/2011	1st Shift	1.00	9.00	0.58	7.42	5,390	9,315	58%	82.4%	599	726	2.21
265351	9112	9/17/2011	1st Shift	0.42	6.50	0.33	5.75	4,601	6,728	68%	88.5%	708	800	1.31
265228	9112	9/16/2011	1st Shift	0.33	9.00	0.50	8.17	6,487	9,315	70%	90.8%	721	794	1.9
264913	9112	9/15/2011	1st Shift	0.33	9.00	1.17	7.50	6,198	9,315	67%	83.3%	689	826	1.51
264508	9112	9/14/2011	1st Shift	* 1.25	9.00	0.08	7.67	6,512	9,315	70%	85.2%	724	849	1.38
264094	9112	9/13/2011	1st Shift	0.33	9.00	0.08	8.59	7,178	9,315	77%	95.4%	798	836	1.65
263665	9112	9/12/2011	1st Shift	0.33	9.00	3.75	4.92	3,712	9,315	40%	54.7%	412	754	1.34
263223	9115	9/9/2011	1st Shift	0.33	8.00	0.42	7.25	6,254	6,416	98%	90.6%	782	863	-0.55
261943	9112	9/6/2011	1st Shift	0.42	8.00	0.17	7.41	6,380	8,280	77%	92.6%	798	861	1.24
261539	9112	9/2/2011	1st Shift	0.75	8.00	0.00	7.25	6,160	8,280	74%	90.6%	770	850	1.3
261147	9114	9/1/2011	1st Shift	* 1.17	8.00	0.58	6.25	4,057	5,072	80%	78.1%	507	649	-0.15
260640	9114	8/31/2011	1st Shift	0.00	8.00	3.42	4.58	2,831	5,072	56%	57.3%	354	618	0.12
260199	9112	8/30/2011	1st Shift	0.75	8.00	1.17	6.08	4,180	8,280	51%	76.0%	523	688	2.04
259784	9112	8/29/2011	1st Shift	0.33	8.00	1.67	6.00	3,630	8,280	44%	75.0%	454	605	2.49
259249	9113	8/26/2011	1st Shift	0.33	8.00	0.08	7.59	6,670	7,032	95%	94.9%	834	879	0
258713	9112	8/25/2011	1st Shift	0.33	8.00	0.08	7.59	5,934	8,280	72%	94.9%	742	782	1.86

Theoretical Produced = ([Sched. Hours] * [MaxObsCapacity]) | Availability = ([Available Hours] / [Sched. Hours]) | Speed Loss = (([Theoretical Produced]*[Availability])-[TonsProduced])/[MaxObsCapacity]) | OEE = [Units Produced]/[Theoretical Produced]

* Sched. Downtime > 1 Hr.

Stage: 21.1-PRI-1-Primary   **OEE Target:** 85%   **Availability Target:** 92%

ID	Mode	Date	Shift	Sched. Down Hrs.	Sched. Hours	Down-time Hours	Av. Hours	Units Produced	Theoretical Produced	OEE	Availability	TPSH	TPAH	Speed Loss
25817	9112	8/24/2011	1st Shift	0.42	8.00	0.42	7.16	5,720	8,280	69%	89.5%	715	799	1.63
25784	9112	8/23/2011	1st Shift	0.42	8.00	1.25	6.33	5,280	8,280	64%	79.1%	660	834	1.23
25741	9112	8/22/2011	1st Shift	0.33	8.00	1.33	6.34	5,170	8,280	62%	79.3%	646	815	1.35
25683	9112	8/19/2011	1st Shift	0.50	8.00	4.67	2.83	2,037	8,280	25%	35.4%	255	720	0.86
25640	9112	8/18/2011	1st Shift	0.25	8.00	0.42	7.33	5,170	8,280	63%	91.6%	646	705	2.33
25598	9116	8/17/2011	1st Shift	0.42	8.00	0.17	7.41	5,830	6,496	90%	92.6%	729	787	0.23
25559	9116	8/16/2011	1st Shift	0.42	8.00	0.50	7.08	5,060	6,496	78%	88.5%	633	715	0.85
25513	9112	8/15/2011	1st Shift	0.33	8.00	3.00	4.67	2,727	8,280	33%	58.4%	341	584	2.04
25457	9112	8/12/2011	1st Shift	* 1.08	8.00	0.17	6.75	5,586	8,280	68%	84.4%	698	828	1.35
25411	9112	8/11/2011	1st Shift	0.42	8.00	0.17	7.41	5,976	8,280	72%	92.6%	747	806	1.63
25359	9112	8/10/2011	1st Shift	0.25	8.00	0.78	6.97	5,161	8,280	62%	87.1%	645	740	1.98
25312	9112	8/9/2011	1st Shift	0.42	8.00	1.08	6.50	4,834	8,280	58%	81.3%	604	744	1.83
25271	9112	8/8/2011	1st Shift	0.42	8.00	1.58	6.00	4,511	8,280	55%	75.0%	564	752	1.64
25223	9111	8/5/2011	1st Shift	0.25	8.00	2.67	5.08	3,936	7,264	54%	63.5%	492	775	0.75
25170	9112	8/4/2011	1st Shift	0.75	8.00	0.83	6.42	4,563	8,280	55%	80.3%	570	711	2.02
25112	9112	8/3/2011	1st Shift	0.00	8.00	1.42	6.58	4,690	8,280	57%	82.3%	586	713	2.05
25078	9112	8/2/2011	1st Shift	0.42	8.00	0.17	7.41	6,904	8,280	83%	92.6%	863	932	0.74
25034	9112	8/1/2011	1st Shift	0.50	8.00	0.08	7.42	5,830	8,280	70%	92.8%	729	786	1.79
24983	9112	7/30/2011	1st Shift	0.00	5.50	0.42	5.08	3,110	5,693	55%	92.4%	565	612	2.08
24982	9112	7/29/2011	1st Shift	0.42	8.00	1.08	6.50	5,060	8,280	61%	81.3%	633	778	1.62
24927	9111	7/28/2011	1st Shift	0.00	8.00	1.08	6.92	5,060	7,264	70%	86.5%	633	731	1.35
24880	9112	7/27/2011	1st Shift	0.33	8.00	2.83	4.84	3,410	8,280	41%	60.5%	426	705	1.55
24843	9112	7/26/2011	1st Shift	0.33	8.00	3.58	4.09	3,725	8,280	45%	51.1%	466	911	0.49
24786	9112	7/25/2011	1st Shift	0.42	8.00	0.58	7.00	4,950	8,280	60%	87.5%	619	707	2.22
24691	9112	7/21/2011	1st Shift	* 5.00	8.00	0.00	3.00	1,734	8,280	21%	37.5%	217	578	1.32
24640	9111	7/20/2011	1st Shift	0.92	8.00	0.67	6.41	4,479	7,264	62%	80.1%	560	699	1.48
24591	9111	7/19/2011	1st Shift	0.33	8.00	2.33	5.34	3,741	7,264	52%	66.8%	468	701	1.22
24552	9111	7/18/2011	1st Shift	0.42	8.00	0.42	7.16	4,950	7,264	68%	89.5%	619	691	1.71
24514	9111	7/15/2011	1st Shift	* 1.25	8.00	0.00	6.75	5,033	7,264	69%	84.4%	629	746	1.21
24449	9111	7/14/2011	1st Shift	0.42	8.00	0.17	7.41	5,965	7,264	82%	92.6%	746	805	0.84
24405	9111	7/13/2011	1st Shift	0.33	8.00	0.08	7.59	5,390	7,264	74%	94.9%	674	710	1.66
24356	9111	7/12/2011	1st Shift	0.25	7.50	0.00	7.25	6,109	6,810	90%	96.7%	815	843	0.52
24307	9111	7/11/2011	1st Shift	0.42	8.00	2.50	5.08	3,902	7,264	54%	63.5%	488	768	0.78
24256	9111	7/8/2011	1st Shift	0.33	8.00	0.58	7.09	3,902	7,264	54%	88.6%	488	550	2.79
24196	9111	7/7/2011	1st Shift	* 5.75	8.00	0.00	2.25	1,071	7,264	15%	28.1%	134	476	1.07
24150	9111	7/6/2011	1st Shift	0.33	8.00	6.00	1.67	1,223	7,264	17%	20.9%	153	732	0.33
24107	9111	7/5/2011	1st Shift	0.33	8.00	0.25	7.42	3,972	7,264	55%	92.8%	497	535	3.05
24020	9111	6/30/2011	1st Shift	* 8.00	8.00	0.00	0.00	0	7,264	0%	0.0%	0	0	0
23975	9111	6/29/2011	1st Shift	* 8.00	8.00	0.00	0.00	0	7,264	0%	0.0%	0	0	0
23917	9111	6/28/2011	1st Shift	0.00	8.00	8.00	0.00	0	7,264	0%	0.0%	0	0	0
23869	9111	6/27/2011	1st Shift	0.33	8.00	2.50	5.17	3,237	7,264	45%	64.6%	405	626	1.6
23822	9111	6/24/2011	1st Shift	0.83	8.00	0.13	7.04	4,950	7,264	68%	88.0%	619	703	1.59
23783	9111	6/23/2011	1st Shift	0.33	8.00	0.75	6.92	4,070	7,264	56%	86.5%	509	588	2.44
23728	9111	6/22/2011	1st Shift	0.33	8.00	0.50	7.17	5,285	7,264	73%	89.6%	661	737	1.35
23695	9111	6/21/2011	1st Shift	0.92	8.00	0.58	6.50	4,503	7,264	62%	81.3%	563	693	1.54
23646	9111	6/20/2011	1st Shift	0.00	8.00	2.33	5.67	3,079	7,264	42%	70.9%	385	543	2.28

Theoretical Produced = ([Sched. Hours] * [MaxObsCapacity]) | Availability = ([Available Hours] / [Sched. Hours]) | Speed Loss = (([Theoretical Produced]*[Availability]) - [TonsProduced]) / [MaxObsCapacity]) | OEE = [Units Produced]/[Theoretical Produced]

* Sched. Downtime > 1 Hr.

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Stage: 21.1-PRI-1-Primary **OEE Target:** 85% **Availability Target:** 92%

ID	Mode	Date	Shift	Sched. Down Hrs.	Sched. Hours	Down-time Hours	Av. Hours	Units Produced	Theoretical Produced	OEE	Availability	TPSH	TPAH	Speed Loss
235888	9116	6/17/2011	1st Shift	0.33	8.00	1.67	6.00	4,459	6,496	69%	75.0%	557	743	0.51
235448	9116	6/16/2011	1st Shift	* 1.08	8.00	0.08	6.84	4,730	6,496	73%	85.5%	591	692	1.01
234884	9116	6/15/2011	1st Shift	0.33	8.00	2.08	5.59	4,238	6,496	65%	69.9%	530	758	0.37
234508	9111	6/14/2011	1st Shift	0.33	8.00	0.08	7.59	5,830	7,264	80%	94.9%	729	768	1.17
234087	9111	6/13/2011	1st Shift	0.25	8.00	0.08	7.67	5,835	7,264	80%	95.9%	729	761	1.25
233354	9111	6/10/2011	1st Shift	1.00	8.00	0.00	7.00	4,730	7,264	65%	87.5%	591	676	1.79
232948	9111	6/9/2011	1st Shift	0.00	8.00	3.00	5.00	3,630	7,264	50%	62.5%	454	726	1
232460	9111	6/8/2011	1st Shift	0.33	8.00	1.00	6.67	4,620	7,264	64%	83.4%	578	693	1.58
231934	9111	6/7/2011	1st Shift	0.42	8.00	0.00	7.58	5,610	7,264	77%	94.8%	701	740	1.41
231465	9111	6/6/2011	1st Shift	0.42	8.00	1.67	5.91	4,730	7,264	65%	73.9%	591	800	0.7
23077	9111	6/3/2011	1st Shift	0.33	8.00	0.08	7.59	5,940	7,264	82%	94.9%	743	783	1.05
230348	9111	6/2/2011	1st Shift	* 1.08	8.00	1.83	5.09	3,371	7,264	46%	63.6%	421	662	1.38
230055	9111	6/1/2011	1st Shift	0.42	8.00	0.08	7.50	4,620	7,264	64%	93.8%	578	616	2.42
229588	9111	5/31/2011	1st Shift	0.33	8.00	2.33	5.34	3,410	7,264	47%	66.8%	426	639	1.59
229063	9111	5/27/2011	1st Shift	0.92	8.00	0.67	6.41	4,510	7,264	62%	80.1%	564	704	1.44
228723	9111	5/26/2011	1st Shift	0.33	8.00	3.83	3.84	2,959	7,264	41%	48.0%	370	771	0.58
228147	9111	5/25/2011	1st Shift	0.00	8.00	2.83	5.17	3,300	7,264	46%	64.6%	413	638	1.53
227863	9111	5/24/2011	1st Shift	0.33	8.00	0.08	7.59	5,700	7,264	79%	94.9%	713	751	1.31
227479	9111	5/23/2011	1st Shift	0.25	8.00	0.92	6.83	4,620	7,264	64%	85.4%	578	676	1.74
226983	9111	5/20/2011	1st Shift	0.42	8.00	0.08	7.50	4,950	7,264	68%	93.8%	619	660	2.05
226394	9111	5/19/2011	1st Shift	0.42	8.00	0.08	7.50	5,280	7,264	73%	93.8%	660	704	1.69
225969	9101	5/18/2011	1st Shift	0.33	8.00	1.17	6.50	4,804	5,912	81%	81.3%	601	739	0
225520	9101	5/17/2011	1st Shift	0.33	8.00	1.25	6.42	4,730	5,912	80%	80.3%	591	737	0.02
225098	9101	5/16/2011	1st Shift	0.92	8.00	0.08	7.00	5,280	5,912	89%	87.5%	660	754	-0.14
224750	9101	5/13/2011	1st Shift	0.33	8.50	3.75	4.42	2,540	6,282	40%	52.0%	299	575	0.98
224253	9101	5/12/2011	1st Shift	0.33	9.00	0.83	7.84	6,193	6,651	93%	87.1%	688	790	-0.54
223827	9101	5/11/2011	1st Shift	0.33	8.00	3.50	4.17	3,801	5,912	64%	52.1%	475	912	-0.98
223323	9101	5/10/2011	1st Shift	0.75	8.00	0.08	7.17	5,180	5,912	88%	89.6%	648	722	0.16
222838	9101	5/9/2011	1st Shift	0.42	8.00	0.08	7.50	5,500	5,912	93%	93.8%	688	733	0.06
222447	9101	5/6/2011	1st Shift	0.92	8.00	0.25	6.83	4,730	5,912	80%	85.4%	591	693	0.43
222007	9101	5/5/2011	1st Shift	0.25	8.00	0.08	7.67	5,500	5,912	93%	95.9%	688	717	0.23
221490	9101	5/4/2011	1st Shift	0.33	8.00	0.08	7.59	5,500	5,912	93%	94.9%	688	725	0.15
221121	9101	5/3/2011	1st Shift	0.33	8.00	0.08	7.59	5,610	5,912	95%	94.9%	701	739	0
220669	9101	5/2/2011	1st Shift	0.42	8.00	0.58	7.00	5,390	5,912	91%	87.5%	674	770	-0.29
220148	9101	4/29/2011	1st Shift	* 1.17	8.00	0.08	6.75	5,390	5,912	91%	84.4%	674	799	-0.54
219788	9101	4/28/2011	1st Shift	0.33	8.17	2.50	5.34	3,520	6,038	58%	65.4%	431	659	0.58
219533	9101	4/27/2011	1st Shift	0.33	8.00	0.08	7.59	5,280	5,912	89%	94.9%	660	696	0.45
219023	9101	4/26/2011	1st Shift	0.00	8.00	8.00	0.00	0	5,912	0%	0.0%	0	0	0
218693	9101	4/25/2011	1st Shift	0.33	8.00	2.33	5.34	4,070	5,912	69%	66.8%	509	762	-0.16
218222	9101	4/22/2011	1st Shift	0.83	8.17	1.17	6.17	4,730	6,038	78%	75.5%	579	767	-0.23
217983	9101	4/21/2011	1st Shift	0.33	8.00	0.17	7.50	5,720	5,912	97%	93.8%	715	763	-0.24
217630	9112	4/20/2011	1st Shift	0.00	8.00	4.42	3.58	2,679	8,280	32%	44.8%	335	748	1
217207	9116	4/19/2011	1st Shift	0.42	8.00	0.00	7.58	4,840	6,496	75%	94.8%	605	639	1.62
216788	9116	4/18/2011	1st Shift	0.33	8.00	0.00	7.67	5,483	6,496	84%	95.9%	685	715	0.92
216409	9112	4/15/2011	1st Shift	0.83	8.50	0.33	7.34	4,620	8,798	52%	86.4%	544	629	2.88
216136	9112	4/14/2011	1st Shift	0.33	8.00	1.75	5.92	4,290	8,280	52%	74.0%	536	725	1.78

Theoretical Produced = ([Sched. Hours] * [MaxObsCapacity]) | Availability = ([Available Hours] / [Sched. Hours] | Speed Loss = (([Theoretical Produced]*[Availability]-[TonsProduced])/[MaxObsCapacity]) | OEE = [Units Produced]/[Theoretical Produced]
*Sched. Downtime > 1 Hr.

73

Stage: 21.1-PRI-1-Primary   **OEE Target:** 85%   **Availability Target:** 92%

ID	Mode	Date	Shift	Sched. Down Hrs.	Sched. Hours	Down-time Hours	Av. Hours	Units Produced	Theoretical Produced	OEE	Availability	TPSH	TPAH	Speed Loss
21542	9101	4/12/2011	1st Shift	0.83	8.50	0.00	7.67	5,170	6,282	82%	90.2%	608	674	0.67
21498	9101	4/11/2011	1st Shift	0.33	8.50	0.00	8.17	5,649	6,282	90%	96.1%	665	691	0.52
21468	9101	4/8/2011	1st Shift	0.83	8.50	1.25	6.42	4,180	6,282	67%	75.5%	492	651	0.76
21399	9116	4/6/2011	1st Shift	0.75	8.50	0.75	7.00	4,620	6,902	67%	82.4%	544	660	1.31
21357	9116	4/5/2011	1st Shift	0.92	8.00	1.92	5.16	1,680	6,496	26%	64.5%	210	326	3.09
20064	9116	12/4/2010	1st Shift	0.00	6.00	0.00	6.00	3,475	4,872	71%	100.0%	579	579	1.72
20057	9101	12/3/2010	1st Shift	0.33	9.50	0.00	9.17	6,380	7,021	91%	96.5%	672	696	0.53
20038	9114	12/2/2010	1st Shift	0.58	9.50	0.75	8.17	4,730	6,023	79%	86.0%	498	579	0.71
20016	9101	12/1/2010	1st Shift	0.00	9.50	2.92	6.58	4,180	7,021	59%	69.3%	440	635	0.93
19971	9101	11/29/2010	1st Shift	0.33	9.00	3.67	5.00	4,730	6,651	71%	55.6%	526	946	-1.4
19928	9101	11/23/2010	1st Shift	0.92	9.00	0.00	8.08	5,610	6,651	84%	89.8%	623	694	0.49
19910	9101	11/22/2010	1st Shift	* 1.25	9.00	0.00	7.75	5,610	6,651	84%	86.1%	623	724	0.16
19869	9101	11/20/2010	1st Shift	0.00	6.50	0.00	6.50	2,410	4,804	50%	100.0%	371	371	3.24
19869	9101	11/19/2010	1st Shift	0.33	8.00	0.00	7.67	5,280	5,912	89%	95.9%	660	688	0.53
19828	9101	11/18/2010	1st Shift	* 1.08	9.50	0.00	8.42	5,610	7,021	80%	88.6%	591	666	0.83
19797	9101	11/17/2010	1st Shift	0.42	9.50	0.58	8.50	5,500	7,021	78%	89.5%	579	647	1.06
19769	9101	11/16/2010	1st Shift	0.33	9.50	0.00	9.17	6,380	7,021	91%	96.5%	672	696	0.53
19736	9101	11/15/2010	1st Shift	* 1.08	9.50	0.00	8.42	5,430	7,021	77%	88.6%	572	645	1.07
19705	9101	11/13/2010	1st Shift	0.00	5.50	0.00	5.50	2,519	4,065	62%	100.0%	458	458	2.09
19701	9101	11/12/2010	1st Shift	0.00	8.00	5.07	2.93	1,755	5,912	30%	36.6%	219	599	0.55
19673	9101	11/11/2010	1st Shift	0.92	9.50	0.00	8.58	5,280	7,021	75%	90.3%	556	615	1.43
19632	9101	11/10/2010	1st Shift	0.33	7.50	0.42	6.75	4,070	5,543	73%	90.0%	543	603	1.24
19595	9101	11/9/2010	1st Shift	0.00	7.00	4.25	2.75	1,870	5,173	36%	39.3%	267	680	0.22
19565	9101	11/8/2010	1st Shift	0.33	7.50	0.00	7.17	4,200	5,543	76%	95.6%	560	586	1.49
19529	9101	11/6/2010	1st Shift	0.00	7.08	0.00	7.08	1,970	5,232	38%	100.0%	278	278	4.41
19529	9101	11/5/2010	1st Shift	0.33	7.50	0.00	7.17	4,900	5,543	88%	95.6%	653	683	0.54
19491	9101	11/4/2010	1st Shift	1.00	7.50	0.00	6.50	4,950	5,543	89%	86.7%	660	762	-0.2
19456	9101	11/3/2010	1st Shift	0.42	9.50	7.00	2.08	3,300	7,021	47%	21.9%	347	1,587	-2.38
19422	9101	11/2/2010	1st Shift	1.00	8.00	2.33	4.67	4,070	5,912	69%	58.4%	509	872	-0.84
19383	9101	11/1/2010	1st Shift	0.50	8.50	1.00	7.00	4,620	6,282	74%	82.4%	544	660	0.75
19305	9101	10/28/2010	1st Shift	* 1.17	7.58	0.00	6.41	4,620	5,602	82%	84.6%	610	721	0.16
19275	9101	10/27/2010	1st Shift	0.50	8.00	0.33	7.17	5,500	5,912	93%	89.6%	688	767	-0.27
19160	9116	10/22/2010	1st Shift	0.42	8.00	0.50	7.08	5,610	6,496	86%	88.5%	701	792	0.17
19119	9116	10/21/2010	1st Shift	0.50	8.00	2.25	5.25	5,060	6,496	78%	65.6%	633	964	-0.98
19083	9116	10/20/2010	1st Shift	0.92	8.00	0.00	7.08	4,390	6,496	68%	88.5%	549	620	1.67
19042	9101	10/19/2010	1st Shift	0.42	8.00	1.42	6.16	4,950	5,912	84%	77.0%	619	804	-0.54
18992	9101	10/18/2010	1st Shift	0.42	9.00	0.00	8.58	2,961	6,651	45%	95.3%	329	345	4.57
18949	9101	10/16/2010	1st Shift	0.00	6.00	0.25	5.75	2,891	4,434	65%	95.8%	482	503	1.84
18907	9112	10/14/2010	1st Shift	* 1.17	8.00	0.50	6.33	4,800	8,280	58%	79.1%	600	758	1.69
18871	9101	10/13/2010	1st Shift	0.42	8.00	0.00	7.58	6,600	5,912	112%	94.8%	825	871	-1.35
18833	9101	10/12/2010	1st Shift	0.50	8.00	0.00	7.50	6,600	5,912	112%	93.8%	825	880	-1.43
18789	9101	10/11/2010	1st Shift	0.00	7.50	3.00	4.50	3,190	5,543	58%	60.0%	425	709	0.18
18736	9101	10/8/2010	1st Shift	0.33	4.50	0.00	4.17	2,800	3,326	84%	92.7%	622	671	0.38
18708	9101	10/7/2010	1st Shift	* 1.08	9.50	0.00	8.42	6,270	7,021	89%	88.6%	660	745	-0.07
18666	9101	10/6/2010	1st Shift	0.50	7.00	0.50	6.00	5,170	5,173	100%	85.7%	739	862	-1
18617	9101	10/5/2010	1st Shift	* 1.08	9.50	0.33	8.09	6,820	7,021	97%	85.2%	718	843	-1.13

Theoretical Produced = ([Sched. Hours] * [MaxObsCapacity]) | Availability = ([Available Hours] / [Sched. Hours]) | Speed Loss = (([Theoretical Produced]*[Availability])-[TonsProduced])/[MaxObsCapacity]) | OEE = [Units Produced]/[Theoretical Produced]

Sched. Downtime > 1 Hr.

74

Stage: 21.1-PRI-1-Primary   **OEE Target:** 85%   **Availability Target:** 92%

ID	Mode	Date	Shift	Sched. Down Hrs.	Sched. Hours	Down-time Hours	Av. Hours	Units Produced	Theoretical Produced	OEE	Availability	TPSH	TPAH	Speed Loss
18558	9101	10/4/2010	1st Shift	0.33	7.50	1.83	5.34	3,850	5,543	69%	71.2%	513	721	0.13
18471	9101	9/30/2010	1st Shift	0.42	9.50	0.92	8.16	6,710	7,021	96%	85.9%	706	822	-0.92
18432	9101	9/29/2010	1st Shift	* 1.17	9.50	0.17	8.16	7,040	7,021	100%	85.9%	741	863	-1.37
18391	9101	9/28/2010	1st Shift	0.58	9.67	1.00	8.09	5,830	7,146	82%	83.7%	603	721	0.2
18346	9101	9/27/2010	1st Shift	* 1.08	8.50	0.92	6.50	4,070	6,282	65%	76.5%	479	626	1
18310	9101	9/25/2010	1st Shift	0.25	6.00	0.33	5.42	2,312	4,434	52%	90.3%	385	427	2.29
18307	9101	9/24/2010	1st Shift	0.83	10.00	0.00	9.17	6,600	7,390	89%	91.7%	660	720	0.24
18263	9101	9/23/2010	1st Shift	0.92	10.00	0.00	9.08	6,270	7,390	85%	90.8%	627	691	0.6
18227	9101	9/22/2010	1st Shift	0.92	9.00	0.00	8.08	5,720	6,651	86%	89.8%	636	708	0.34
18185	9101	9/21/2010	1st Shift	1.00	10.00	0.58	8.42	5,280	7,390	71%	84.2%	528	627	1.28
18149	9101	9/20/2010	1st Shift	0.92	10.00	0.58	8.50	7,040	7,390	95%	85.0%	704	828	-1.03
18104	9101	9/17/2010	1st Shift	0.92	9.50	0.00	8.58	6,710	7,021	96%	90.3%	706	782	-0.5
18063	9101	9/16/2010	1st Shift	* 1.17	10.00	0.00	8.83	5,830	7,390	79%	88.3%	583	660	0.94
18024	9101	9/15/2010	1st Shift	0.58	10.00	1.25	8.17	5,092	7,390	69%	81.7%	509	623	1.28
17984	9101	9/14/2010	1st Shift	0.33	10.00	3.00	6.67	4,400	7,390	60%	66.7%	440	660	0.72
17945	9101	9/13/2010	1st Shift	* 1.25	10.00	0.08	8.67	6,380	7,390	86%	86.7%	638	736	0.04
17907	9101	9/10/2010	1st Shift	* 1.08	10.00	0.17	8.75	6,710	7,390	91%	87.5%	671	767	-0.33
17855	9116	9/9/2010	1st Shift	0.92	9.17	0.00	8.25	5,720	7,446	77%	90.0%	624	693	1.21
17818	9101	9/8/2010	1st Shift	0.75	10.00	3.42	5.83	5,390	7,390	73%	58.3%	539	925	-1.46
17776	9101	9/7/2010	1st Shift	* 3.58	10.00	0.00	6.42	4,400	7,390	60%	64.2%	440	685	0.47
17738	9101	9/3/2010	1st Shift	0.50	7.00	0.08	6.42	5,060	5,173	98%	91.7%	723	788	-0.43
17707	9101	9/2/2010	1st Shift	0.75	10.50	0.08	9.67	7,810	7,760	101%	92.1%	744	808	-0.9
17669	9101	9/1/2010	1st Shift	* 1.17	10.08	0.17	8.74	7,260	7,390	97%	86.7%	720	831	-1.08
17628	9101	8/31/2010	1st Shift	1.00	8.58	0.00	7.58	5,500	6,341	87%	88.3%	641	726	0.13
17589	9101	8/30/2010	1st Shift	* 1.42	10.00	0.00	8.58	5,500	7,390	74%	85.8%	550	641	1.14
17544	9101	8/27/2010	1st Shift	* 1.17	9.00	0.50	7.33	5,500	6,651	83%	81.4%	611	750	-0.12
17494	9101	8/26/2010	1st Shift	0.67	8.00	1.92	5.41	3,410	5,912	58%	67.6%	426	630	0.79
17468	9101	8/25/2010	1st Shift	0.33	7.50	3.58	3.59	2,420	5,543	44%	47.9%	323	674	0.32
17434	9101	8/24/2010	1st Shift	1.00	9.50	0.67	7.83	4,950	7,021	71%	82.4%	521	632	1.13
17394	9101	8/23/2010	1st Shift	0.42	8.00	0.83	6.75	4,730	5,912	80%	84.4%	591	701	0.35
17361	9101	8/20/2010	1st Shift	1.00	11.00	3.67	6.33	6,820	8,129	84%	57.5%	620	1,077	-2.9
17307	9101	8/19/2010	1st Shift	0.92	11.17	0.75	9.50	7,700	8,255	93%	85.0%	689	811	-0.92
17266	9101	8/18/2010	1st Shift	* 1.28	11.50	2.25	7.97	5,500	8,499	65%	69.3%	478	690	0.53
17218	9101	8/17/2010	1st Shift	1.00	11.50	2.42	8.08	5,830	8,499	69%	70.3%	507	722	0.2
17181	9101	8/16/2010	1st Shift	* 1.58	11.50	0.83	9.09	5,980	8,499	70%	79.0%	520	658	0.99
17144	9101	8/13/2010	1st Shift	* 1.05	11.50	0.25	10.20	6,490	8,499	76%	88.7%	564	636	1.42
17090	9112	8/12/2010	1st Shift	* 1.33	11.50	0.67	9.50	7,150	11,903	60%	82.6%	622	753	2.59
17051	9112	8/11/2010	1st Shift	0.50	11.50	7.83	3.17	2,750	11,903	23%	27.6%	239	868	0.52
17015	9112	8/10/2010	1st Shift	* 1.07	11.96	1.70	9.18	5,170	12,368	42%	76.8%	433	563	4.18
16980	9112	8/9/2010	1st Shift	1.00	11.50	0.83	9.67	7,260	11,903	61%	84.1%	631	751	2.66
16934	9112	8/6/2010	1st Shift	* 1.17	10.00	1.00	7.83	6,930	10,350	67%	78.3%	693	885	1.13
16902	9112	8/5/2010	1st Shift	0.92	11.50	0.75	9.83	6,930	11,903	58%	85.5%	603	705	3.14
16862	9112	8/4/2010	1st Shift	0.83	11.50	0.00	10.67	8,910	11,903	75%	92.8%	775	835	2.06
16828	9112	8/3/2010	1st Shift	1.00	11.00	0.92	9.08	7,040	11,385	62%	82.5%	640	775	2.27
16791	9101	8/2/2010	1st Shift	0.83	11.50	9.25	1.42	3,088	8,499	36%	12.3%	269	2,175	-2.76
16740	9101	7/30/2010	1st Shift	0.42	11.50	2.00	9.08	6,160	8,499	72%	79.0%	536	678	0.75

Theoretical Produced = ([Sched. Hours] * [MaxObsCapacity]) | Availability = ([Available Hours] / [Sched. Hours]) | Speed Loss = (([Theoretical Produced]*[Availability]-[TonsProduced])/[MaxObsCapacity]) | OEE = [Units Produced]/[Theoretical Produced]

           * Sched. Downtime > 1 Hr.

Stage: 21.1-PRI-1-Primary OEE Target: 85% Availability Target: 92%

ID	Mode	Date	Shift	Sched. Down Hrs.	Sched. Hours	Down-time Hours	Av. Hours	Units Produced	Theoretical Produced	OEE	Availability	TPSH	TPAH	Speed Loss
167065	9101	7/29/2010	1st Shift	* 1.25	11.50	0.25	10.00	8,870	8,499	104%	87.0%	771	887	-2
166711	9101	7/28/2010	1st Shift	0.83	11.50	4.75	5.92	4,180	8,499	49%	51.5%	363	706	0.27
166304	9101	7/27/2010	1st Shift	1.00	11.50	0.50	10.00	7,810	8,499	92%	87.0%	679	781	-0.56
165889	9101	7/26/2010	1st Shift	* 1.08	9.00	0.00	7.92	5,720	6,651	86%	88.0%	636	722	0.18
165551	9101	7/23/2010	1st Shift	1.00	11.50	0.00	10.50	8,360	8,499	98%	91.3%	727	796	-0.81
164986	9115	7/22/2010	1st Shift	0.92	9.50	0.00	8.58	6,050	7,619	79%	90.3%	637	705	1.03
164539	9112	7/21/2010	1st Shift	0.92	10.50	1.75	7.83	6,270	10,868	58%	74.6%	597	801	1.78
164112	9101	7/20/2010	1st Shift	0.92	8.00	0.25	6.83	5,060	5,912	86%	85.4%	633	741	-0.02
163784	9101	7/19/2010	1st Shift	0.00	8.00	3.25	4.75	3,300	5,912	56%	59.4%	413	695	0.29
163414	9101	7/17/2010	1st Shift	0.00	5.00	0.00	5.00	2,612	3,695	71%	100.0%	522	522	1.47
163410	9101	7/16/2010	1st Shift	0.67	11.00	2.00	8.33	5,720	8,129	70%	75.7%	520	687	0.59
162999	9101	7/15/2010	1st Shift	0.92	11.00	0.00	10.08	8,800	8,129	108%	91.6%	800	873	-1.83
162691	9101	7/14/2010	1st Shift	0.33	8.00	2.00	5.67	4,003	5,912	68%	70.9%	500	706	0.26
162230	9101	7/13/2010	1st Shift	0.00	11.50	5.42	6.08	5,194	8,499	61%	52.9%	452	854	-0.94
161877	9101	7/12/2010	1st Shift	0.92	9.50	0.75	7.83	5,610	7,021	80%	82.4%	591	716	0.24
161462	9101	7/10/2010	1st Shift	0.00	6.00	0.42	5.58	3,682	4,434	83%	93.0%	614	660	0.6
161318	9116	7/9/2010	1st Shift	0.92	10.00	0.17	8.91	7,590	8,120	94%	89.1%	759	852	-0.44
160979	9116	7/8/2010	1st Shift	0.50	10.50	1.37	8.63	5,720	8,526	67%	82.2%	545	663	1.59
160639	9101	7/7/2010	1st Shift	0.35	8.00	7.08	0.57	1,980	5,912	34%	7.1%	248	3,474	-2.11
160272	9101	7/6/2010	1st Shift	0.42	7.97	0.08	7.47	5,610	5,890	95%	93.7%	704	751	-0.12
159922	9101	7/2/2010	1st Shift	0.25	7.50	2.00	5.25	3,902	5,543	70%	70.0%	520	743	-0.03
159522	9101	7/1/2010	1st Shift	0.33	9.50	3.92	5.25	3,190	7,021	45%	55.3%	336	608	0.94
159047	9101	6/30/2010	1st Shift	1.00	9.50	3.83	4.67	4,070	7,021	58%	49.2%	428	872	-0.83
158665	9101	6/29/2010	1st Shift	0.92	9.50	0.42	8.16	6,270	7,021	89%	85.9%	660	768	-0.32
158194	9112	6/28/2010	1st Shift	0.92	9.50	1.67	6.91	5,390	9,833	55%	72.7%	567	780	1.7
157580	9112	6/25/2010	1st Shift	0.33	9.50	3.50	5.67	5,390	9,833	55%	59.7%	567	951	0.46
157235	9112	6/24/2010	1st Shift	* 2.83	9.50	0.42	6.25	4,840	9,833	49%	65.8%	509	774	1.57
156841	9112	6/23/2010	1st Shift	* 1.12	9.50	0.08	8.30	7,590	9,833	77%	87.4%	799	914	0.97
156501	9112	6/22/2010	1st Shift	* 1.37	9.58	2.25	5.96	4,730	9,915	48%	62.2%	494	794	1.39
156177	9112	6/21/2010	1st Shift	* 1.05	9.50	0.00	8.45	7,040	9,833	72%	88.9%	741	833	1.64
155804	9112	6/18/2010	1st Shift	0.58	9.50	1.92	7.00	5,170	9,833	53%	73.7%	544	739	2.01
155418	9112	6/17/2010	1st Shift	* 1.27	9.50	1.33	6.90	5,940	9,833	60%	72.6%	625	861	1.16
155037	9112	6/16/2010	1st Shift	0.67	9.50	1.83	7.00	5,390	9,833	55%	73.7%	567	770	1.79
154680	9101	6/15/2010	1st Shift	0.33	9.50	5.42	3.75	2,640	7,021	38%	39.5%	278	704	0.18
154309	9101	6/14/2010	1st Shift	* 1.08	9.50	0.92	7.50	6,160	7,021	88%	78.9%	648	821	-0.84
153980	9101	6/11/2010	1st Shift	0.33	9.58	0.00	9.25	6,270	7,080	89%	96.6%	654	678	0.77
153531	9112	6/10/2010	1st Shift	0.00	9.75	8.75	1.00	631	10,091	6%	10.3%	65	631	0.39
153150	9116	6/9/2010	1st Shift	0.83	9.50	3.00	5.67	4,168	7,714	54%	59.7%	439	735	0.54
152708	9112	6/8/2010	1st Shift	1.00	9.50	1.50	7.00	4,290	9,833	44%	73.7%	452	613	2.86
152350	9112	6/7/2010	1st Shift	* 1.08	9.50	0.00	8.42	6,710	9,833	68%	88.6%	706	797	1.93
151954	9112	6/4/2010	1st Shift	* 1.03	9.50	0.07	8.40	6,380	9,833	65%	88.4%	672	760	2.23
151467	9112	6/3/2010	1st Shift	* 1.08	9.50	0.08	8.34	6,600	9,833	67%	87.8%	695	791	1.96
151054	9112	6/2/2010	1st Shift	* 1.20	9.50	0.50	7.80	6,270	9,833	64%	82.1%	660	804	1.74
150644	9101	6/1/2010	1st Shift	0.92	9.50	1.83	6.75	5,390	7,021	77%	71.1%	567	799	-0.54
150201	9112	5/28/2010	1st Shift	0.42	8.00	2.25	5.33	4,290	8,280	52%	66.6%	536	805	1.18
149781	9112	5/27/2010	1st Shift	* 1.08	9.50	0.00	8.42	6,710	9,833	68%	88.6%	706	797	1.93

Theoretical Produced = ([Sched. Hours] * [MaxObsCapacity]) | Availability = ([Available Hours] / [Sched. Hours]) | Speed Loss = ((([Theoretical Produced]*[Availability])-[TonsProduced])/[MaxObsCapacity]) | OEE = [Units Produced]/[Theoretical Produced]

* Sched. Downtime > 1 Hr.

ID	Mode	Date	Shift	Sched. Down Hrs.	Sched. Hours	Down-time Hours	Av. Hours	Units Produced	Theoretical Produced	OEE	Availability	TPSH	TPAH	Speed Loss
149405	9112	5/26/2010	1st Shift	0.42	8.08	0.08	7.58	5,760	8,363	69%	93.8%	713	760	2.01
148991	9112	5/25/2010	1st Shift	0.92	8.50	0.00	7.58	6,600	8,798	75%	89.2%	776	871	1.21
148514	9112	5/24/2010	1st Shift	1.00	9.50	1.00	7.50	6,330	9,833	64%	78.9%	666	844	1.38
148275	9112	5/22/2010	1st Shift	0.00	5.50	0.50	5.00	2,747	5,693	48%	90.9%	499	549	2.35
148269	9112	5/21/2010	1st Shift	0.33	9.50	5.08	4.09	2,640	9,833	27%	43.1%	278	645	1.54
147790	9112	5/20/2010	1st Shift	0.92	9.50	2.00	6.58	5,060	9,833	51%	69.3%	533	769	1.69
147355	9116	5/19/2010	1st Shift	* 1.17	9.50	0.00	8.33	6,380	7,714	83%	87.7%	672	766	0.47
146964	9116	5/18/2010	1st Shift	1.00	9.50	0.75	7.75	6,160	7,714	80%	81.6%	648	795	0.17
146605	9112	5/17/2010	1st Shift	0.92	9.50	2.25	6.33	5,696	9,833	58%	66.6%	600	900	0.82
146253	9112	5/15/2010	1st Shift	0.00	5.50	0.33	5.17	3,111	5,693	55%	94.0%	566	602	2.16
146248	9112	5/14/2010	1st Shift	0.92	9.50	0.00	8.58	6,930	9,833	71%	90.3%	729	808	1.88
145880	9112	5/13/2010	1st Shift	* 1.17	9.50	0.00	8.33	6,270	9,833	64%	87.7%	660	753	2.27
145587	9112	5/12/2010	1st Shift	1.00	9.00	1.17	6.83	5,880	9,315	63%	75.9%	653	861	1.15
145229	9112	5/11/2010	1st Shift	0.00	9.08	8.00	1.08	1,105	9,398	12%	11.9%	122	1,023	0.01
144803	9112	5/10/2010	1st Shift	1.00	9.00	0.28	7.72	5,390	9,315	58%	85.8%	599	698	2.51
144551	9112	5/7/2010	1st Shift	* 8.00	8.00	0.00	0.00	0	8,280	0%	0.0%	0	0	0
144143	9112	5/6/2010	1st Shift	0.83	8.08	0.00	7.25	5,170	8,363	62%	89.7%	640	713	2.25
143841	9112	5/5/2010	1st Shift	1.00	9.00	0.00	8.00	5,940	9,315	64%	88.9%	660	742	2.26
143485	9112	5/4/2010	1st Shift	* 7.00	9.00	0.00	2.00	1,639	9,315	18%	22.2%	182	820	0.41
143118	9112	5/3/2010	1st Shift	* 1.17	9.00	0.75	7.08	6,159	9,315	66%	78.7%	684	870	1.13
142764	9112	4/30/2010	1st Shift	1.00	9.00	0.37	7.63	6,498	9,315	70%	84.8%	722	852	1.35
142329	9116	4/29/2010	1st Shift	0.92	9.00	0.00	8.08	6,820	7,308	93%	89.8%	758	844	-0.32
141929	9101	4/28/2010	1st Shift	* 1.08	9.50	0.00	8.42	6,375	7,021	91%	88.6%	671	757	-0.21
141552	9101	4/27/2010	1st Shift	0.95	9.17	0.00	8.22	5,863	6,777	87%	89.6%	639	713	0.28
141160	9101	4/26/2010	1st Shift	* 4.08	9.00	1.50	3.42	1,913	6,651	29%	38.0%	213	559	0.83
140760	9101	4/23/2010	1st Shift	0.58	7.00	0.00	6.42	4,584	5,173	89%	91.7%	655	714	0.22
140512	9101	4/22/2010	1st Shift	0.00	7.50	2.00	5.50	4,566	5,543	82%	73.3%	609	830	-0.68
140183	9101	4/21/2010	1st Shift	* 1.20	9.00	0.50	7.30	6,160	6,651	93%	81.1%	684	844	-1.04
139778	9101	4/20/2010	1st Shift	0.92	8.00	1.25	5.83	4,598	5,912	78%	72.9%	575	789	-0.39
139540	9101	4/19/2010	1st Shift	0.83	8.25	0.33	7.09	5,969	6,097	98%	85.9%	724	842	-0.99
139211	9101	4/16/2010	1st Shift	0.50	7.25	0.20	6.55	6,234	5,358	116%	90.3%	860	952	-1.89
138999	9101	4/15/2010	1st Shift	0.97	8.00	0.00	7.03	6,587	5,912	111%	87.9%	823	937	-1.88
162677	9101	4/14/2010	1st Shift	0.33	8.17	1.92	5.92	4,003	6,038	66%	72.5%	490	676	0.51
138698	9101	4/14/2010	1st Shift	0.83	9.00	1.57	6.60	5,959	6,651	90%	73.3%	662	903	-1.47
138375	9101	4/13/2010	1st Shift	0.33	9.03	0.25	8.45	6,205	6,673	93%	93.6%	687	734	0.06
138064	9112	4/12/2010	1st Shift	1.00	9.00	0.58	7.42	4,617	9,315	50%	82.4%	513	622	2.96
137866	9101	4/9/2010	1st Shift	0.97	9.00	0.25	7.78	5,725	6,651	86%	86.4%	636	736	0.03
137632	9115	4/8/2010	1st Shift	* 1.07	9.00	0.03	7.90	4,900	7,218	68%	87.8%	544	620	1.79
137329	9101	4/7/2010	1st Shift	0.92	9.00	1.17	6.91	3,540	6,651	53%	76.8%	393	512	2.12
137076	9115	4/6/2010	1st Shift	* 1.42	9.08	0.25	7.41	3,600	7,282	49%	81.6%	396	486	2.92
136834	9115	4/5/2010	1st Shift	0.25	9.00	2.08	6.67	2,600	7,218	36%	74.1%	289	390	3.43
136578	9101	4/2/2010	1st Shift	0.00	2.50	0.00	2.50	700	1,848	38%	100.0%	280	280	1.55
12490	9101	11/20/2009	1st Shift	0.50	8.50	0.00	8.00	3,322	6,282	53%	94.1%	391	415	3.5
124573	9116	11/19/2009	1st Shift	* 1.47	8.58	0.00	7.11	5,300	6,967	76%	82.9%	618	745	0.59
124342	9101	11/18/2009	1st Shift	* 1.03	9.50	0.00	8.47	4,800	7,021	68%	89.2%	505	567	1.98
124063	9101	11/17/2009	1st Shift	0.33	9.67	4.25	5.09	2,800	7,146	39%	52.6%	290	550	1.3

Theoretical Produced = ([Sched. Hours] * [MaxObsCapacity]) | Availability = ([Available Hours] / [Sched. Hours]) | Speed Loss = (([Theoretical Produced]*[Availability])-[TotalProduced])/[MaxObsCapacity]) | OEE = [Units Produced]/[Theoretical Produced]

* Sched. Downtime > 1 Hr.

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Stage: 21.1-PRI-1-Primary | **OEE Target:** 85% **Availability Target:** 92%

ID	Mode	Date	Shift	Sched. Down Hrs.	Sched. Hours	Down-time Hours	Av. Hours	Units Produced	Theoretical Produced	OEE	Availability	TPSH	TPAH	Speed Loss
123749	9101	11/16/2009	1st Shift	* 5.17	9.50	0.00	4.33	2,400	7,021	34%	45.6%	253	554	1.08
123488	9101	11/13/2009	1st Shift	* 1.17	9.50	0.17	8.16	6,900	7,021	98%	85.9%	726	846	-1.18
123198	9101	11/12/2009	1st Shift	* 1.17	9.50	0.00	8.33	6,500	7,021	93%	87.7%	684	780	-0.46
122771	9101	11/11/2009	1st Shift	* 1.03	9.50	0.83	7.64	5,500	7,021	78%	80.4%	579	720	0.2
122452	9101	11/10/2009	1st Shift	* 1.18	9.50	0.58	7.74	5,500	7,021	78%	81.5%	579	711	0.3
122193	9101	11/9/2009	1st Shift	1.00	9.50	2.58	5.92	4,400	7,021	63%	62.3%	463	743	-0.04
121858	9112	11/7/2009	1st Shift	0.00	3.25	0.00	3.25	1,940	3,364	58%	100.0%	597	597	1.38
121853	9112	11/6/2009	1st Shift	* 1.17	9.50	2.50	5.83	4,400	9,833	45%	61.4%	463	755	1.58
121540	9112	11/5/2009	1st Shift	0.50	9.50	0.00	9.00	7,000	9,833	71%	94.7%	737	778	2.23
121210	9116	11/4/2009	1st Shift	0.00	9.50	0.20	9.30	7,000	7,714	91%	97.9%	737	753	0.68
120887	9112	11/3/2009	1st Shift	* 1.08	9.50	1.33	7.09	5,100	9,833	52%	74.6%	537	719	2.16
120519	9112	11/2/2009	1st Shift	* 1.02	9.50	0.50	7.98	7,200	9,833	73%	84.0%	758	902	1.02
120274	9113	10/30/2009	1st Shift	0.70	9.50	2.67	6.13	4,400	8,351	53%	64.5%	463	718	1.12
119937	9112	10/29/2009	1st Shift	0.80	9.50	4.47	4.23	4,100	9,833	42%	44.5%	432	969	0.27
119599	9112	10/28/2009	1st Shift	0.93	8.00	0.00	7.07	5,400	8,280	65%	88.4%	675	764	1.85
11925	9112	10/27/2009	1st Shift	* 1.07	9.00	1.87	6.06	4,095	9,315	44%	67.3%	455	676	2.1
11894	9112	10/26/2009	1st Shift	0.00	9.50	0.20	9.30	6,550	9,833	67%	97.9%	689	704	2.97
118644	9113	10/24/2009	1st Shift	0.00	5.00	0.00	5.00	3,300	4,395	75%	100.0%	660	660	1.25
11864	9112	10/23/2009	1st Shift	0.00	3.88	1.20	2.68	2,000	4,016	50%	69.1%	515	746	0.75
118640	9116	10/23/2009	1st Shift	0.75	5.62	0.00	4.87	3,600	4,563	79%	86.7%	641	739	0.44
118288	9116	10/22/2009	1st Shift	0.00	3.88	0.95	2.93	2,100	3,151	67%	75.5%	541	717	0.34
118288	9112	10/22/2009	1st Shift	0.65	5.62	0.33	4.64	3,300	5,817	57%	82.6%	587	711	1.45
117590	9112	10/20/2009	1st Shift	0.00	9.50	0.82	8.68	5,900	9,833	60%	91.4%	621	680	2.98
117212	9101	10/19/2009	1st Shift	0.50	8.08	0.90	6.68	5,200	5,971	87%	82.7%	644	778	-0.35
116864	9112	10/17/2009	1st Shift	0.17	5.50	0.17	5.16	4,000	5,693	70%	93.8%	727	775	1.29
116685	9112	10/16/2009	1st Shift	0.00	9.12	0.00	9.12	7,100	9,439	75%	100.0%	779	779	2.26
116470	9112	10/15/2009	1st Shift	0.52	10.00	4.27	5.21	3,300	10,350	32%	52.1%	330	633	2.02
116146	9112	10/14/2009	1st Shift	0.55	10.05	3.68	5.82	4,400	10,402	42%	57.9%	438	756	1.57
11584	9112	10/13/2009	1st Shift	* 1.17	9.50	0.23	8.10	5,600	9,833	57%	85.3%	589	691	2.69
115496	9101	10/12/2009	1st Shift	0.45	10.00	1.12	8.43	7,133	7,390	97%	84.3%	713	846	-1.22
115201	9101	10/9/2009	1st Shift	* 1.33	9.62	0.33	7.96	4,600	7,109	65%	82.7%	478	578	1.73
114558	9112	10/7/2009	1st Shift	0.00	7.50	7.50	0.00	0	7,763	0%	0.0%	0	0	0
11411	9112	10/6/2009	1st Shift	0.00	7.50	7.50	0.00	0	7,763	0%	0.0%	0	0	0
11377	9101	10/5/2009	1st Shift	* 1.12	7.50	0.00	6.38	4,700	5,543	85%	85.1%	627	737	0.02
113363	9112	10/2/2009	1st Shift	0.00	9.00	9.00	0.00	0	9,315	0%	0.0%	0	0	0
112984	9112	10/1/2009	1st Shift	0.00	9.00	9.00	0.00	0	9,315	0%	0.0%	0	0	0
11263	9112	9/30/2009	1st Shift	0.00	9.00	9.00	0.00	0	9,315	0%	0.0%	0	0	0
112287	9112	9/29/2009	1st Shift	0.48	8.50	0.92	7.10	5,330	8,798	61%	83.5%	627	751	1.95
11191	9112	9/28/2009	1st Shift	* 1.55	9.00	0.00	7.45	6,200	9,315	67%	82.8%	689	832	1.46
11153	9112	9/25/2009	1st Shift	* 1.37	8.00	0.00	6.63	5,200	8,280	63%	82.9%	650	784	1.61
111078	9112	9/24/2009	1st Shift	* 1.30	9.00	0.17	7.53	5,865	9,315	63%	83.7%	652	779	1.87
110701	9112	9/23/2009	1st Shift	* 1.25	9.52	0.75	7.52	6,255	9,853	63%	79.0%	657	832	1.48
110336	9112	9/22/2009	1st Shift	* 1.35	9.50	0.47	7.68	6,600	9,833	67%	80.8%	695	859	1.3
109910	9112	9/21/2009	1st Shift	* 1.40	9.50	0.00	8.10	6,885	9,833	70%	85.3%	725	850	1.45
109578	9112	9/18/2009	1st Shift	* 1.23	9.50	0.00	8.27	6,900	9,833	70%	87.1%	726	834	1.61
109139	9112	9/17/2009	1st Shift	* 1.28	9.50	0.47	7.75	6,750	9,833	69%	81.6%	711	871	1.23

Theoretical Produced = ([Sched. Hours] * [MaxObsCapacity]) | Availability = ([Available Hours] / [Sched. Hours]) | Speed Loss = ((([Theoretical Produced]*[Availability])-[TonsProduced])/[MaxObsCapacity]) | OEE = [Units Produced]/[Theoretical Produced]

* Sched. Downtime > 1 Hr.

Stage: 21.1-PRI-1-Primary   OEE Target: 85%   Availability Target: 92%

ID	Mode	Date	Shift	Sched. Down Hrs.	Sched. Hours	Down-time Hours	Av. Hours	Units Produced	Theoretical Produced	OEE	Availability	TPSH	TPAH	Speed Loss
108807	9101	9/16/2009	1st Shift	* 1.23	9.50	0.30	7.97	6,700	7,021	95%	83.9%	705	841	-1.1
10846	9101	9/15/2009	1st Shift	* 1.27	9.50	0.50	7.73	6,425	7,021	91%	81.4%	676	831	-0.96
10808	9101	9/14/2009	1st Shift	* 1.38	9.50	0.50	7.62	6,395	7,021	91%	80.2%	673	839	-1.03
10771	9101	9/11/2009	1st Shift	0.00	9.50	0.00	9.50	7,200	7,021	103%	100.0%	758	758	-0.24
107344	9101	9/10/2009	1st Shift	0.98	10.00	5.07	3.95	2,900	7,390	39%	39.5%	290	734	0.03
106992	9101	9/9/2009	1st Shift	0.75	10.00	1.00	8.25	6,600	7,390	89%	82.5%	660	800	-0.68
10661	9101	9/8/2009	1st Shift	0.00	10.00	2.75	7.25	6,411	7,390	87%	72.5%	641	884	-1.43
10631	9101	9/4/2009	1st Shift	0.00	5.00	0.00	5.00	3,833	3,695	104%	100.0%	767	767	-0.19
106040	9101	9/3/2009	1st Shift	* 1.28	10.00	2.00	6.72	5,300	7,390	72%	67.2%	530	789	-0.45
105753	9101	9/2/2009	1st Shift	* 1.20	10.00	1.13	7.67	6,710	7,390	91%	76.7%	671	875	-1.41
105360	9116	9/1/2009	1st Shift	0.00	10.00	2.40	7.60	6,100	8,120	75%	76.0%	610	803	0.09
10498	9116	8/31/2009	1st Shift	0.00	10.00	4.75	5.25	3,950	8,120	49%	52.5%	395	752	0.39
104486	9101	8/28/2009	1st Shift	0.00	9.50	0.50	9.00	7,500	7,021	107%	94.7%	789	833	-1.15
10425	9101	8/27/2009	1st Shift	0.00	9.53	0.67	8.86	7,025	7,043	100%	93.0%	737	793	-0.64
103805	9101	8/26/2009	1st Shift	0.00	8.75	0.00	8.75	6,000	6,466	93%	100.0%	686	686	0.63
103422	9116	8/25/2009	1st Shift	0.00	3.78	0.28	3.50	2,900	3,069	94%	92.6%	767	829	-0.07
103424	9112	8/25/2009	1st Shift	0.00	6.28	2.58	3.70	3,100	6,500	48%	58.9%	494	838	0.7
103049	9112	8/24/2009	1st Shift	0.55	10.03	2.17	7.30	6,185	10,371	60%	72.9%	617	847	1.33
102628	9112	8/21/2009	1st Shift	* 1.08	10.00	1.98	6.94	5,740	10,350	56%	69.4%	574	827	1.39
102170	9112	8/20/2009	1st Shift	0.92	5.35	2.00	2.43	2,425	5,537	44%	45.4%	453	998	0.09
102167	9116	8/20/2009	1st Shift	0.57	4.65	0.57	3.51	3,350	3,776	89%	75.5%	720	954	-0.61
101807	9112	8/19/2009	1st Shift	0.00	10.02	0.77	9.25	7,795	10,371	75%	92.3%	778	843	1.72
101384	9112	8/18/2009	1st Shift	0.00	10.03	2.43	7.60	6,100	10,381	59%	75.8%	608	803	1.71
101028	9112	8/17/2009	1st Shift	0.00	9.00	0.00	9.00	7,600	9,315	82%	100.0%	844	844	1.66
100659	9112	8/15/2009	1st Shift	0.43	4.79	0.37	3.95	3,100	4,916	63%	83.2%	653	785	0.96
100649	9112	8/14/2009	1st Shift	0.50	10.00	3.62	5.88	4,200	10,350	41%	58.8%	420	714	1.82
100301	9112	8/13/2009	1st Shift	0.38	10.05	0.00	9.67	8,100	10,402	78%	96.2%	806	838	1.84
99904	9112	8/12/2009	1st Shift	0.00	9.32	0.05	9.27	7,100	9,646	74%	99.5%	762	766	2.41
99540	9112	8/11/2009	1st Shift	0.00	8.25	0.00	8.25	7,445	8,539	87%	100.0%	902	902	1.06
99202	9112	8/10/2009	1st Shift	0.70	9.63	0.00	8.93	8,300	9,967	83%	92.7%	862	929	0.91
98772	9112	8/8/2009	1st Shift	0.45	5.55	0.00	5.10	4,200	5,744	73%	91.9%	757	824	1.04
98770	9112	8/7/2009	1st Shift	0.00	5.17	0.00	5.17	4,815	5,351	90%	100.0%	931	931	0.52
98769	9116	8/7/2009	1st Shift	0.00	4.00	0.63	3.37	2,945	3,248	91%	84.3%	736	874	-0.25
98315	9112	8/6/2009	1st Shift	0.53	8.03	0.00	7.50	7,065	8,311	85%	93.4%	880	942	0.67
37936	9112	8/5/2009	1st Shift	* 1.12	8.05	0.00	6.93	6,805	8,332	82%	86.1%	845	982	0.36
97555	9116	8/4/2009	1st Shift	0.00	1.42	0.00	1.42	1,100	1,153	95%	100.0%	775	775	0.07
97557	9113	8/4/2009	1st Shift	0.62	7.08	1.03	5.43	4,000	6,223	64%	76.7%	565	737	0.88
97093	9112	8/3/2009	1st Shift	* 1.35	9.52	0.30	7.87	6,200	9,853	63%	82.7%	651	788	1.88
96816	9112	8/1/2009	1st Shift	0.43	5.67	0.53	4.71	3,700	5,868	63%	83.1%	653	786	1.14
96840	9116	8/1/2009	1st Shift	0.00	1.00	0.00	1.00	700	812	86%	100.0%	700	700	0.14
96808	9112	7/31/2009	1st Shift	0.43	9.50	0.98	8.09	6,500	9,833	66%	85.2%	684	803	1.81
96291	9112	7/30/2009	1st Shift	0.42	8.50	0.68	7.40	5,600	8,798	64%	87.1%	659	757	1.99
96290	9116	7/30/2009	1st Shift	0.00	1.57	0.00	1.57	1,300	1,275	102%	100.0%	828	828	-0.03
95914	9112	7/29/2009	1st Shift	0.00	10.00	3.27	6.73	5,100	10,350	49%	67.3%	510	758	1.8
95488	9112	7/28/2009	1st Shift	* 1.20	9.55	0.43	7.92	6,700	9,884	68%	82.9%	702	846	1.44
95170	9113	7/27/2009	1st Shift	* 1.10	10.00	0.08	8.82	7,000	8,790	80%	88.2%	700	794	0.86

Theoretical Produced = ([Sched. Hours] * [MaxObsCapacity]) | Availability = ([Available Hours] / [Sched. Hours]) | Speed Loss = ((([Theoretical Produced]*[Availability]-
[TonsProduced])/[MaxObsCapacity]) | OEE = [Units Produced]/[Theoretical Produced]

     * Sched. Downtime > 1 Hr.

Stage: 21.1-PRI-1-Primary   **OEE Target:** 85%   **Availability Target:** 92%

ID	Mode	Date	Shift	Sched. Down Hrs.	Sched. Hours	Down-time Hours	Av. Hours	Units Produced	Theoretical Produced	OEE	Availability	TPSH	TPAH	Speed Loss
98822	9112	7/24/2009	1st Shift	0.00	9.50	3.63	5.87	3,600	9,833	37%	61.8%	379	613	2.39
94283	9112	7/23/2009	1st Shift	* 1.12	9.50	0.10	8.28	6,800	9,833	69%	87.2%	716	821	1.71
93894	9112	7/22/2009	1st Shift	* 1.08	8.00	0.48	6.44	6,017	8,280	73%	80.5%	752	934	0.63
93515	9112	7/21/2009	1st Shift	0.93	10.00	0.23	8.84	6,900	10,350	67%	88.4%	690	781	2.17
93100	9112	7/20/2009	1st Shift	* 1.33	8.50	0.67	6.50	5,500	8,798	62%	76.5%	647	846	1.19
92696	9112	7/18/2009	1st Shift	0.28	5.87	0.88	4.71	3,500	6,075	58%	80.2%	596	743	1.33
92693	9112	7/17/2009	1st Shift	0.00	10.00	2.32	7.68	6,000	10,350	58%	76.8%	600	781	1.88
92485	9112	7/16/2009	1st Shift	0.40	10.00	3.05	6.55	5,100	10,350	49%	65.5%	510	779	1.62
101043	9112	7/15/2009	1st Shift	* 1.22	8.09	0.77	6.06	4,600	8,332	55%	75.3%	571	759	1.62
101046	9112	7/14/2009	1st Shift	* 1.47	8.50	0.28	6.75	5,100	8,798	58%	79.4%	600	756	1.82
101048	9112	6/26/2009	1st Shift	* 1.25	9.55	0.12	8.18	6,000	9,884	61%	85.7%	628	733	2.39
101050	9112	6/25/2009	1st Shift	* 1.27	9.52	0.37	7.88	6,300	9,853	64%	82.8%	662	799	1.8
101064	9112	6/23/2009	1st Shift	0.63	8.10	1.13	6.34	5,200	8,384	62%	78.3%	642	820	1.32
101073	9112	6/19/2009	1st Shift	0.73	7.57	0.08	6.76	6,100	7,835	78%	89.3%	806	902	0.87
101084	9112	6/18/2009	1st Shift	0.60	9.09	0.27	8.18	5,900	9,367	63%	90.4%	652	721	2.48
101087	9112	6/17/2009	1st Shift	0.00	9.50	0.00	9.50	6,739	9,833	69%	100.0%	709	709	2.99
101088	9101	6/16/2009	1st Shift	0.00	9.50	0.32	9.18	7,426	7,021	106%	96.6%	782	809	-0.87
101093	9101	6/15/2009	1st Shift	0.57	7.60	0.80	6.23	3,876	5,616	69%	82.0%	510	622	0.99
101097	9101	6/12/2009	1st Shift	0.82	9.50	2.67	6.01	5,400	7,021	77%	63.3%	568	899	-1.29
101108	9101	6/11/2009	1st Shift	0.58	9.33	0.35	8.40	5,406	6,895	78%	90.0%	579	644	1.08
101110	9101	6/10/2009	1st Shift	0.57	9.52	0.62	8.33	6,514	7,035	93%	87.5%	684	782	-0.48
81419	9101	6/9/2009	1st Shift	0.00	9.55	1.02	8.53	5,019	7,057	71%	89.3%	526	588	1.74
80997	9101	6/8/2009	1st Shift	0.00	9.50	2.53	6.97	4,514	7,021	64%	73.4%	475	648	0.86
80846	9101	6/5/2009	1st Shift	* 1.33	7.50	0.00	6.17	4,589	5,543	83%	82.3%	612	744	-0.04
80844	9101	6/4/2009	1st Shift	* 1.37	9.10	0.03	7.70	5,563	6,725	83%	84.6%	611	722	0.17
80840	9101	6/3/2009	1st Shift	* 1.42	9.50	0.53	7.55	5,097	7,021	73%	79.5%	537	675	0.66
80838	9112	6/2/2009	1st Shift	* 8.00	8.00	0.00	0.00	0	8,280	0%	0.0%	0	0	0
80835	9112	6/1/2009	1st Shift	* 8.00	8.00	0.00	0.00	0	8,280	0%	0.0%	0	0	0
78880	9101	5/29/2009	1st Shift	0.57	7.50	0.78	6.15	4,488	5,543	81%	82.0%	598	730	0.08
78883	9112	5/28/2009	1st Shift	0.55	7.52	0.48	6.49	5,127	7,783	66%	86.3%	682	790	1.54
78885	9112	5/27/2009	1st Shift	0.57	7.50	0.17	6.76	4,866	7,763	63%	90.1%	649	720	2.06
80832	9112	5/26/2009	1st Shift	* 1.28	8.02	0.00	6.74	4,560	8,301	55%	84.0%	569	677	2.33
78889	9112	5/22/2009	1st Shift	0.00	7.60	0.07	7.53	5,708	7,866	73%	99.1%	751	758	2.02
80742	9112	5/21/2009	1st Shift	0.00	8.05	5.58	2.47	1,623	8,332	20%	30.7%	202	657	0.9
80829	9112	5/20/2009	1st Shift	0.58	8.57	0.45	7.54	5,828	8,870	66%	88.0%	680	773	1.91
80751	9112	5/19/2009	1st Shift	* 1.27	8.00	1.93	4.80	3,917	8,280	47%	60.0%	490	816	1.02
80771	9112	5/18/2009	1st Shift	* 1.30	9.58	0.18	8.10	6,135	9,915	62%	84.6%	640	757	2.18
80774	9112	5/15/2009	1st Shift	* 1.27	9.50	1.57	6.66	5,100	9,833	52%	70.1%	537	766	1.73
80777	9112	5/14/2009	1st Shift	* 1.30	9.50	0.00	8.20	5,508	9,833	56%	86.3%	580	672	2.88
80782	9112	5/13/2009	1st Shift	0.60	9.50	0.28	8.62	6,430	9,833	65%	90.7%	677	746	2.4
80785	9112	5/12/2009	1st Shift	* 1.15	9.58	0.08	8.35	6,728	9,915	68%	87.2%	702	806	1.85
80796	9112	5/11/2009	1st Shift	0.52	9.50	0.80	8.18	6,414	9,833	65%	86.1%	675	784	1.98
80800	9112	5/8/2009	1st Shift	0.50	8.50	1.25	6.75	5,408	8,798	62%	79.4%	636	801	1.52
80803	9112	5/7/2009	1st Shift	0.50	7.50	0.00	7.00	5,330	7,763	69%	93.3%	711	761	1.85
80806	9112	5/6/2009	1st Shift	0.42	9.50	0.25	8.83	6,613	9,833	67%	92.9%	696	749	2.44
80810	9112	5/5/2009	1st Shift	0.42	8.50	0.58	7.50	5,832	8,798	66%	88.2%	686	778	1.86

Theoretical Produced = ([Sched. Hours] * [MaxObsCapacity]) | Availability = ([Available Hours] / [Sched. Hours]) | Speed Loss = (([Theoretical Produced]*[Availability]-
[TonsProduced])/[MaxObsCapacity]) | OEE = [Units Produced]/[Theoretical Produced]
    *Sched. Downtime > 1 Hr.

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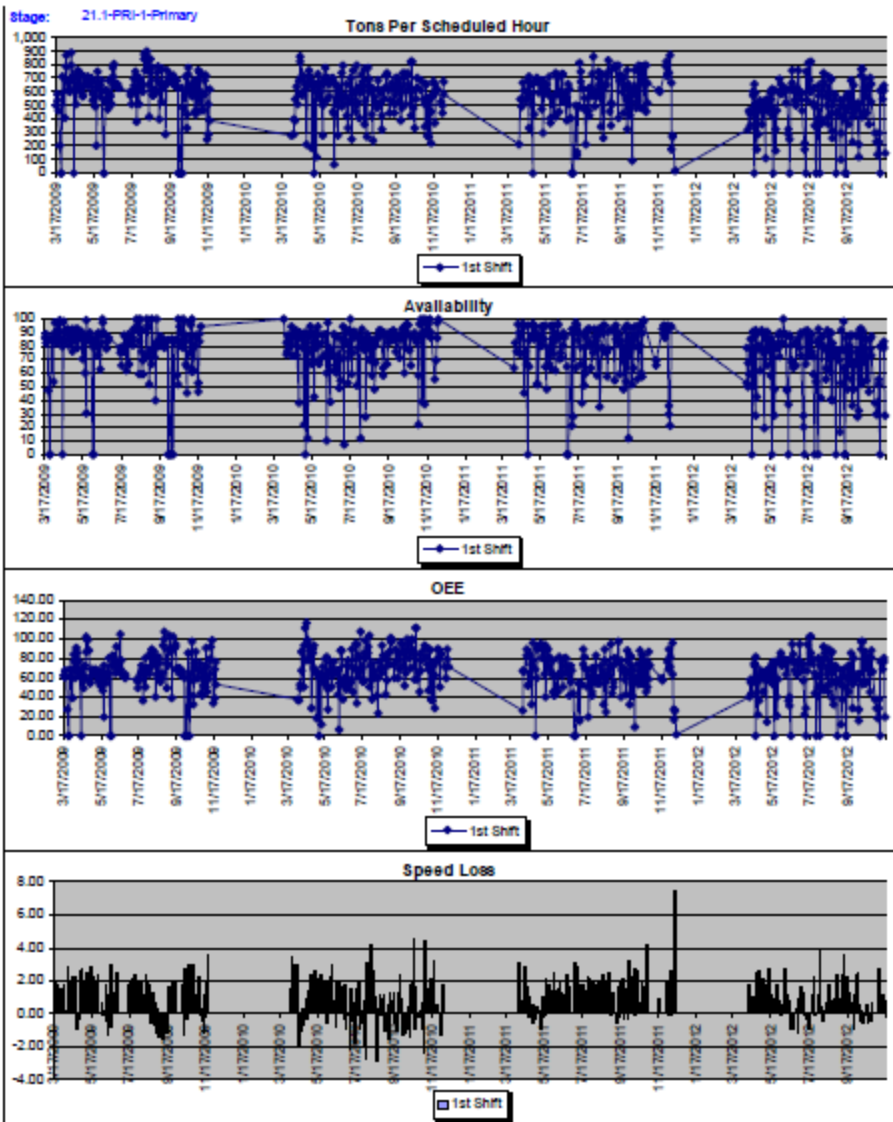| Stage:	21.1-PRI-1-Primary									OEE Target: 85%	Availability Target: 92%			
ID	Mode	Date	Shift	Sched. Down Hrs.	Sched. Hours	Down-time Hours	Av. Hours	Units Produced	Theoretical Produced	OEE	Availability	TPSH	TPAH	Speed Loss
80814	9112	5/4/2009	1st Shift	* 1.42	8.50	0.00	7.08	5,747	8,798	65%	83.3%	676	812	1.53
80818	9112	5/1/2009	1st Shift	0.60	8.55	0.35	7.60	6,097	8,849	69%	88.9%	713	802	1.71
71734	9112	4/30/2009	1st Shift	0.58	8.60	0.00	8.02	5,531	8,901	62%	93.3%	643	690	2.68
71462	9112	4/29/2009	1st Shift	0.48	9.52	1.80	7.24	5,516	9,853	56%	76.1%	579	762	1.92
71132	9112	4/28/2009	1st Shift	* 1.28	8.50	0.00	7.22	4,825	8,798	55%	84.9%	568	668	2.55
70818	9101	4/27/2009	1st Shift	* 1.37	9.58	0.17	8.04	6,212	7,080	88%	83.9%	648	773	-0.37
70816	9101	4/24/2009	1st Shift	0.78	9.50	0.00	8.72	6,921	7,021	99%	91.8%	729	794	-0.64
70168	9101	4/23/2009	1st Shift	* 1.15	9.58	0.63	7.80	6,132	7,080	87%	81.4%	640	786	-0.5
69873	9101	4/22/2009	1st Shift	0.52	9.50	0.20	8.78	7,104	7,021	101%	92.4%	748	809	-0.83
69720	9112	4/21/2009	1st Shift	0.62	8.67	0.00	8.05	6,603	8,973	74%	92.8%	762	820	1.67
69712	9112	4/20/2009	1st Shift	0.00	7.50	0.75	6.75	4,655	7,763	60%	90.0%	621	690	2.25
69709	9112	4/18/2009	1st Shift	0.33	5.00	0.48	4.19	2,567	5,175	50%	83.8%	513	613	1.71
69699	9112	4/17/2009	1st Shift	0.00	9.60	0.77	8.83	6,824	9,936	69%	92.0%	711	773	2.24
69687	9112	4/16/2009	1st Shift	* 1.28	9.50	0.18	8.04	6,308	9,833	64%	84.6%	664	785	1.94
69692	9112	4/15/2009	1st Shift	0.00	7.50	0.17	7.33	5,351	7,763	69%	97.7%	713	730	2.16
69680	9112	4/14/2009	1st Shift	* 9.50	9.50	0.00	0.00	0	9,833	0%	0.0%	0	0	0
69675	9112	4/13/2009	1st Shift	0.15	9.50	1.72	7.63	5,933	9,833	60%	80.3%	625	778	1.9
69661	9112	4/10/2009	1st Shift	0.52	9.52	0.47	8.53	7,582	9,853	77%	89.6%	796	889	1.2
67627	9112	4/9/2009	1st Shift	0.00	9.50	0.08	9.42	8,461	9,833	86%	99.2%	891	898	1.25
67360	9112	4/8/2009	1st Shift	0.00	9.50	0.40	9.10	6,503	9,833	66%	95.8%	685	715	2.82
67629	9101	4/7/2009	1st Shift	0.00	9.50	1.62	7.88	5,710	7,021	81%	82.9%	601	725	0.15
67205	9101	4/6/2009	1st Shift	0.33	8.50	0.33	7.84	5,688	6,282	91%	92.2%	669	726	0.14
66751	9112	4/3/2009	1st Shift	0.00	7.65	1.35	6.30	4,703	7,918	59%	82.4%	615	747	1.76
66561	9112	4/2/2009	1st Shift	0.00	9.08	0.23	8.85	7,890	9,398	84%	97.5%	869	892	1.23
66279	9112	4/1/2009	1st Shift	0.00	9.13	0.92	8.21	7,164	9,450	76%	89.9%	785	873	1.29
66076	9112	3/31/2009	1st Shift	0.00	8.58	1.27	7.31	5,970	8,880	67%	85.2%	696	817	1.54
65901	9112	3/30/2009	1st Shift	0.00	8.50	3.92	4.58	3,460	8,798	39%	53.9%	407	755	1.24
65876	9112	3/27/2009	1st Shift	0.00	8.50	1.15	7.35	6,045	8,798	69%	86.5%	711	822	1.51
65879	9101	3/25/2009	1st Shift	* 8.50	8.50	0.00	0.00	0	6,282	0%	0.0%	0	0	0
65878	9101	3/24/2009	1st Shift	* 8.50	8.50	0.00	0.00	0	6,282	0%	0.0%	0	0	0
65869	9101	3/23/2009	1st Shift	0.00	8.50	4.52	3.98	1,697	6,282	27%	46.8%	200	426	1.68
65868	9101	3/20/2009	1st Shift	0.25	9.00	1.25	7.50	4,128	6,651	62%	83.3%	459	550	1.91
65867	9113	3/19/2009	1st Shift	0.45	9.00	0.52	8.03	5,269	7,911	67%	89.2%	585	656	2.03
65865	9113	3/18/2009	1st Shift	* 1.17	9.07	0.50	7.40	4,900	7,973	61%	81.6%	540	662	1.83
65864	9115	3/17/2009	1st Shift	0.67	9.00	0.60	7.73	4,518	7,218	63%	85.9%	502	584	2.1
Shift Totals			1st Shift:	583	5,898	901	4,414	3,270,384	5,121,946	65%	74.8%	554	741	592
			2nd Shift:	0	0	0	0	0	0	0%	0.0%	0	0	0
			3rd Shift:	0	0	0	0	0	0	0%	0.0%	0	0	0
			Total:	583	6,898	901	4,414	3,270,384	6,121,846	85%	74.8%	564	741	582

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Theoretical Produced = ([Sched. Hours] * [MaxObsCapacity]) | Availability = ([Available Hours] / [Sched. Hours]) | Speed Loss = (([Theoretical Produced]*[Availability]-[TotalProduced])/[MaxObsCapacity]) | OEE = [Units Produced]/[Theoretical Produced]
* Sched. Downtime > 1 Hr.

Stage: 21.1-PRI-1-Primary

Tons Per Scheduled Hour

1st Shift

Availability

1st Shift

OEE

1st Shift

Speed Loss

1st Shift

Theoretical Produced = ([Sched. Hours] * [MaxObsCapacity]) | Availability = ([Available Hours] / [Sched. Hours]) | Speed Loss = (([Theoretical Produced]*[Availability]-
[TonsProduced])/[MaxObsCapacity]) | OEE = [Units Produced]/[Theoretical Produced]   * Sched. Downtime > 1 Hr.

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