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ABC Company

Compressed Air System Measurement Report

Measurement Dates: October 2021

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About Compressed Air Alliance

Compressed Air Alliance are experts in the compressed air industry. We work with manufacturers to reduce compressed air demand and improve the efficiency and reliability of compressed air systems.

We offer leakage surveys, auditing, purity testing, consulting, training, system upgrades, monitoring and repairs of compressed air systems. We also provide temporary and permanent measurement, system controls and monitoring equipment.

For more information on Compressed Air Alliance, please see our website: www.compressedairalliance.com or email sales@compressedairalliance.com.

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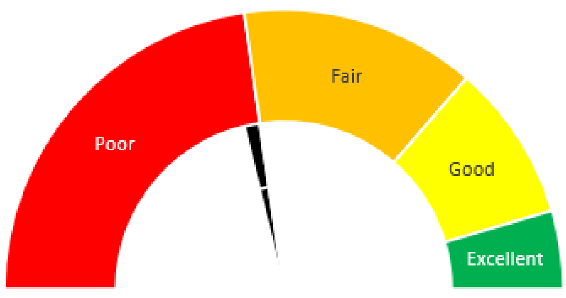
Introduction

Compressed Air Alliance conducted an audit of the compressed air system at ABC Company in October 2021. The audit included establishing the operating costs of the compressed air system, measuring the performance of the compressed air system and making recommendations on improving the compressed air system.

As part of the audit, Compressed Air Alliance installed temporary sensors and data loggers to measure flow, pressure, current, dew point and temperature. Data was recorded at 1 second intervals for a period of approximately 168 hours (1 week). Based on system measurement the compressed air system is estimated to cost approximately **$45,242 per year** which equates to approximately 12% of the site's annual electricity.

System Health Indicator

Based on system efficiency, pressure drop and dew point, your compressed air system health is rated as Poor.



Indicator	Health Score
Efficiency	Poor
Pressure Drop	Fair
Dew Point	Good
Overall	**Poor**

Recommendations

Based on the system measurement and observations of the site, the following actions may improve efficiency and reduce operating costs of your compressed air system.

- Undertake a compressed air leak audit and repair program (refer to 'Flow') to reduce wasted air consumption (refer to 'System Measurement - Flow')
- Investigate the run on timer for compressor 2 as this compressor is not shutting down when unloaded (refer to 'System Measurement - Power')
- Check dryer or the condensate drains for performance issues (refer to 'System Measurement – Dew Point')
- Compressors are oversized for the system. When upgrading the compressed air system, select appropriately sized compressors with automatic control (refer to 'System Measurement – System Efficiency')
- When upgrading the compressed air system, consider pipework and filtration upgrades to reduce pressure drops (refer to 'System Measurement – Pressure')
- Receiver capacity is undersized. Consider adding another 3-4m³ of receiver capacity (refer to 'System Measurement – System Efficiency').

Compressed Air System

ABC Company's compressed air system consists of 2 compressors, 2 receivers, 2 dryers, and associated filters. Based on the logged data, the system is typically operated 24 hours per day, 6 days per week

Compressors

There are two Kaeser fixed speed, oil lubricated screw compressors.

- Compressor 1 – Kaeser ASD60
- Compressor 2 – Kaeser AS44

Receivers

There are two wet receivers, one per compressor.

Dryers

There are two refrigerated air dryers, one per compressor.

- Dryer 1 – PMD105/AC
- Dryer 2 – Kaeser TC44

Filters

Each compressor/dryer combination is fitted with pre and post filtration.

Pipework

Pipework is mostly stainless steel or copper tube, in either DN50 for the main system and larger compressor or DN40 for the smaller compressor.

System Measurement

Compressed Air Alliance installed flow, pressure, current, dew point and temperature sensors on the compressed air system. Data was recorded for a period of approximately 168 hours (1 week) and was analysed to provide the following graphs. The data was used to estimate usage over a full year (8760 hours).

Measurement Results

Measurement	Results
Site's Electricity Use	Usage = 2,504,817 kWh per year Cost = $388,140 per year Electricity Unit Cost = $0.155 per kWh (inc all fees and charges) Based on electricity bills supplied by site
Compressed air electricity use	Usage = 291,964 kWh per year Cost = $45,242 per year Equates to approximately 12% of the site's total electricity use
Cost of compressed air	Average = $4.00 per 100/m³
Compressed air consumption	1,129,782 m³ per year
Average system pressure	Wet Pressure = 7.40 barg Dry Pressure = 7.07 barg Pressure Drop = 0.33 barg
Efficiency of compressors system (Specific Power)	Average = 20.93 kW/m3/min Max = 76.65 kW/m3/min
System flow rate	Average Demand = 2.29 m3/min Max Demand = 4.93 m3/min Min Demand = 0.00 m3/min

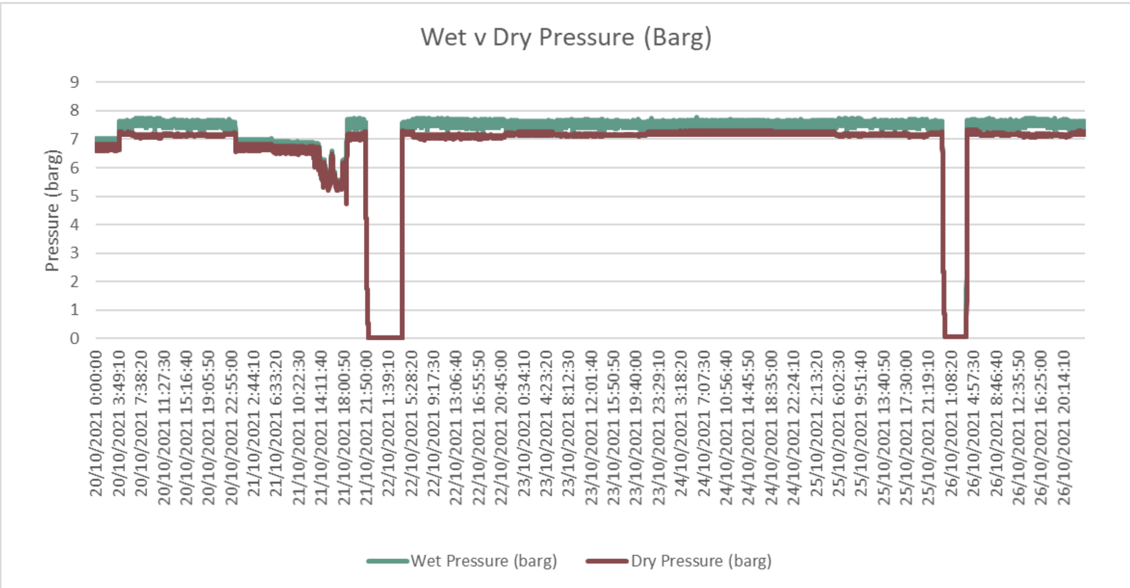
Pressure

Pressure monitoring at multiple points can be used to identify issues with compressors, filters, dryers, and pipework. Differential pressure across filters can be used to establish optimum intervals for element replacement helping to maintain system efficiency.

Wet pressure was measured on both wet receivers; however, the difference was negligible. For ease of clarity in the graphs, only the wet pressure from the receiver connected to compressor 1 is shown.

The system operates with an average wet pressure of 7.40 bar(g) and dry pressure of 7.07 bar(g). The average pressure drop is 0.33 bar(g) which is on the upper limits of normal. Given the low average flow rates for the system capacity, this would indicate there are potential significant losses in the filtration and pipework of the current system.

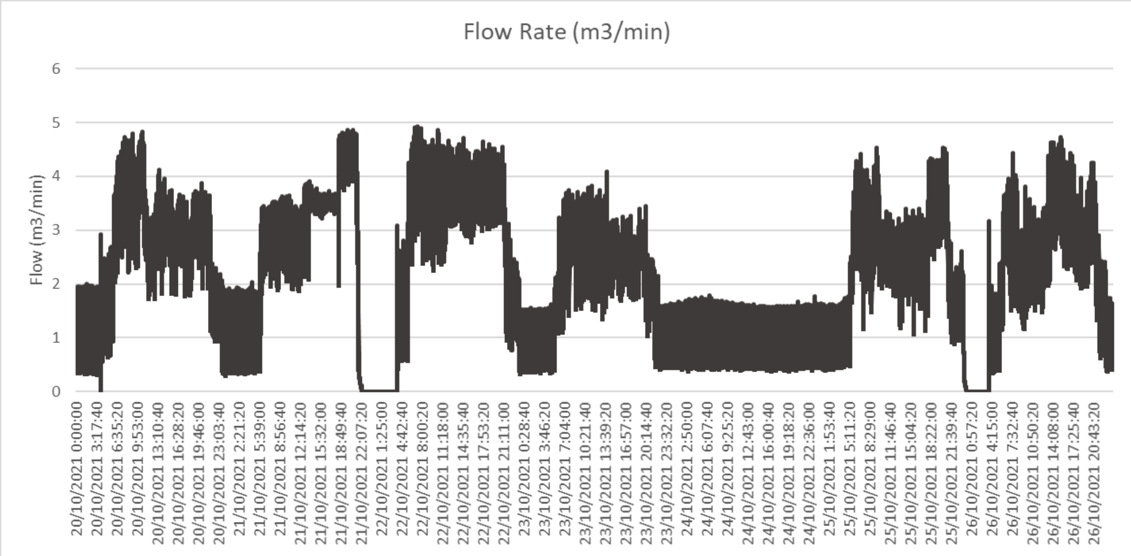
Should demand increase, the pressure drop would also increase leading to a notable increase in wasted energy. The system design should be improved to eliminate these losses when new equipment is installed.



Flow

Flow metering is used to understand compressed air consumption, identify compressor issues, establish compressor or system efficiency, and monitor for changes in the system such as increases in leakage.

The average flow rate was 2.29m³/min with a peak of 4.93m³/min. The minimum recorded flow was 0, with the system off, however during a period of non-production overnight an average flow of 1.1m³/min was recorded. This indicates that leakage and non-productive demands could be as high as **48%** of the total demand.

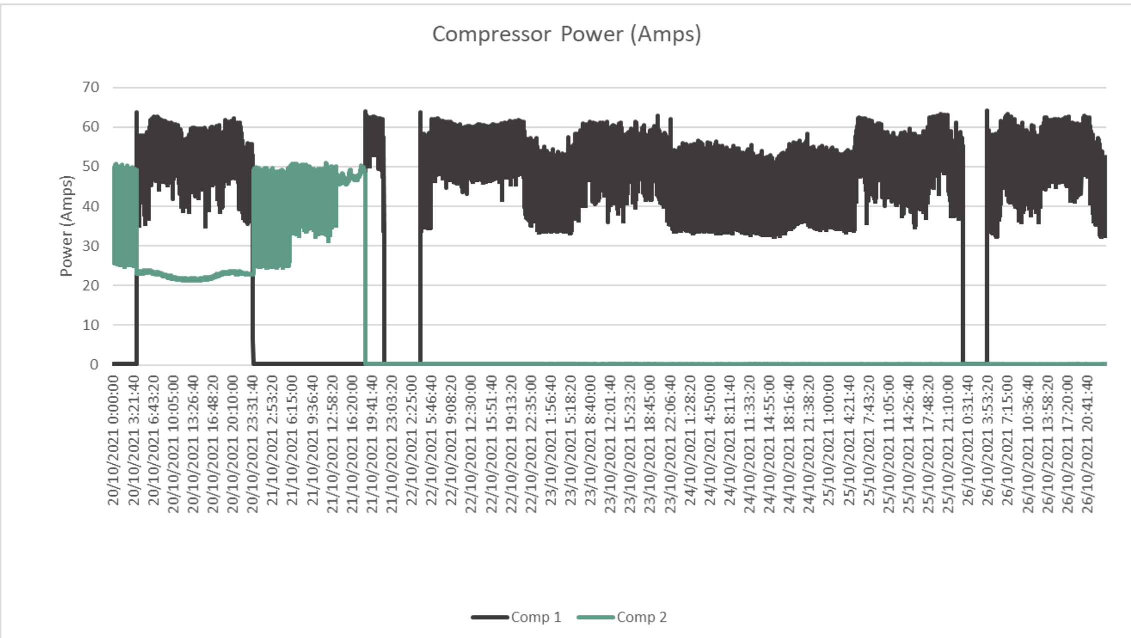


Power Consumption

Measuring current or power on a compressor provides insight into how much energy a compressor uses, how long it operates, when it is producing compressed air and how it interacts with the other compressors on the system. Additionally, power, or current can be used to diagnose issue within the compressor by looking in fine detail at the profile and characteristics of the power usage.

Both compressors ran during the measurement period. At the beginning of the data, compressor 2 can be seen running loaded until compressor one is turned on. Compressor 2 continues to run unloaded for several hours until compressor 1 is turned off, where compressor 2 starts to load again. Compressors 1 and 2 appear to be switched over later the third day, where only compressor 1 runs for the remainder of the period.

The load/unload profile of both compressors indicates that both machines are in reasonable working order. However, compressor 2 appears to have an issue with the run on timer as it should have shut itself down after 10-15 minutes of running unloaded.

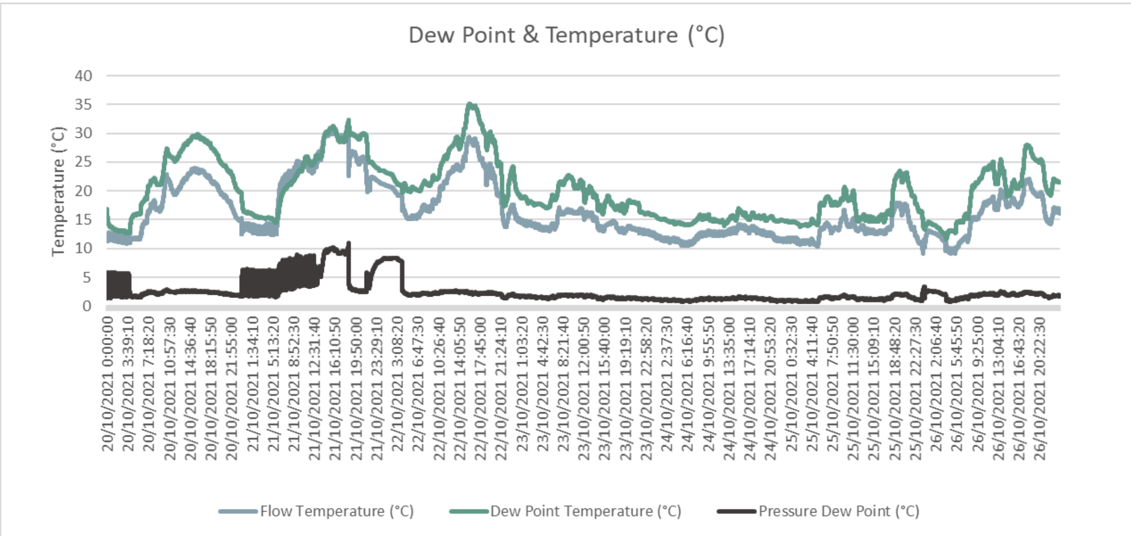


The system appears to be manually controlled, which leads to errors in which compressor is the most efficient and suitable to be running at any point in time leading to wasted energy on a regular basis.

Dew Point & Temperature

Moisture in compressed air can cause significant increases in maintenance costs by causing corrosion and component failure as well as directly affecting production performance. Measuring dew point and ambient temperature is the simplest way to monitor dryer performance and detect moisture issues before they can cause a problem.

The average dew point for the system was 2.28°C with a peak of 10.91°C. When compared to the power data of each compressor, the dew point increased notably when compressor 2 was running. This indicates there is an issue with either the dryer or the condensate drains associated with compressor 2. This should be checked and rectified as soon as possible. Until the issue is rectified, the system should be operated on compressor 1 as a priority to avoid downstream issues with moisture and long term maintenance issues with downstream equipment.



Compressed Air System Efficiency

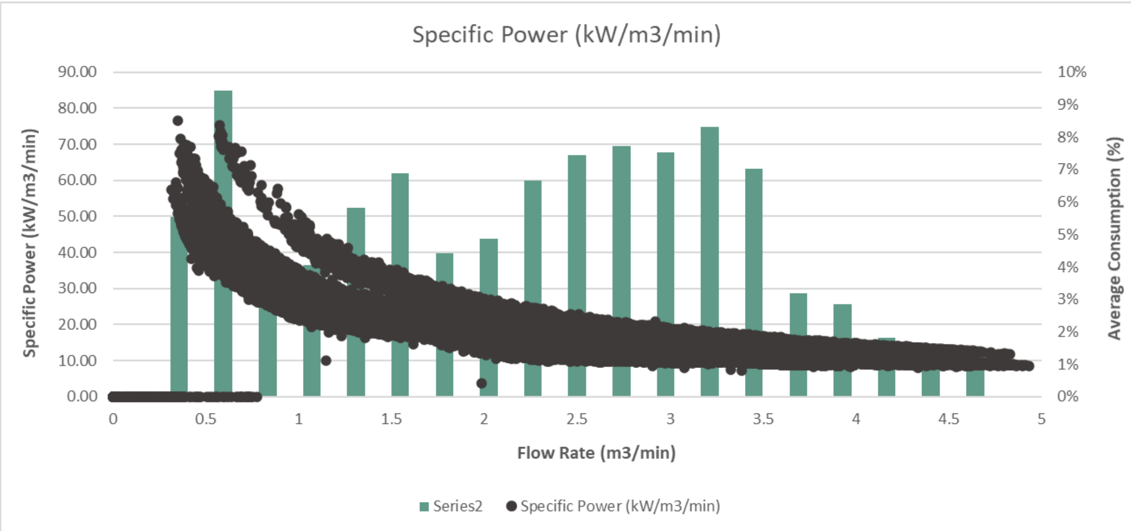
Compressed air system efficiency is a measure of how much energy the system will use for a given flow rate. It is typically measured in kW/m³/min with higher numbers meaning more energy is being consumed to produce the required flow.

The average system efficiency was 20.93kW/m³/min with a peak of 76.93kW/m³/min. Best practice suggests a system efficiency of between 7-8kW/m³/min is achievable. By improving the system efficiency, the annual energy consumption of the system could be reduced by $28,000/year.

There are two main factors contributing to the inefficiency of the system:

1. The compressors are incorrectly sized and controlled for the system demands.
    a. The graph below shows the system efficiency in black vs the demand profile in green.

   b. The average and peak demand is well below the compressor capacity which forces the compressor to operate in an inefficient state.
   c. Selecting and controlling the correct compressors will save approximately $20,000/year in energy.
2. The receiver capacity is undersized for the installed compressors.
   a. While not clearly shown in the graphs, the compressors continuously cycle from load to unload and back multiple times per minute. This increases the average power draw of the compressors by not allowing it to completely unload before having to load again.
   b. Increasing the receiver capacity allows the compressor to spend more time either loaded or unloaded, improving the average energy use. Best practices suggest a total receiver capacity of between 50-65% of the trimming compressors capacity.
   c. For this system the receiver capacity should be between 3-4m³. Increasing the receiver capacity will save approximately $8,000/year in energy.

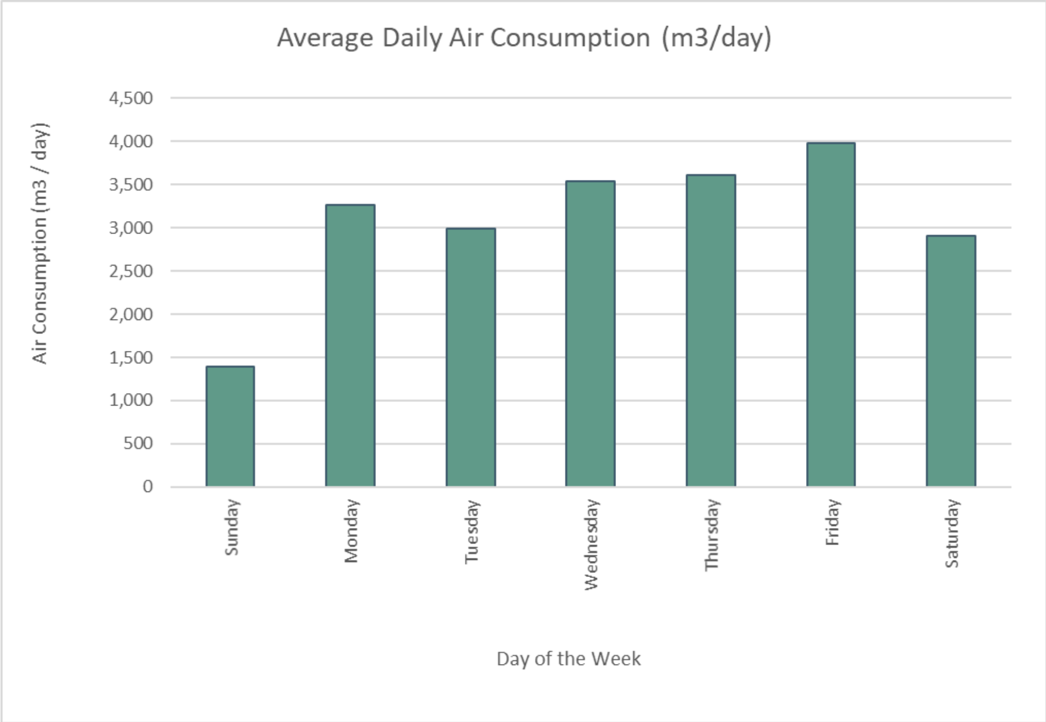


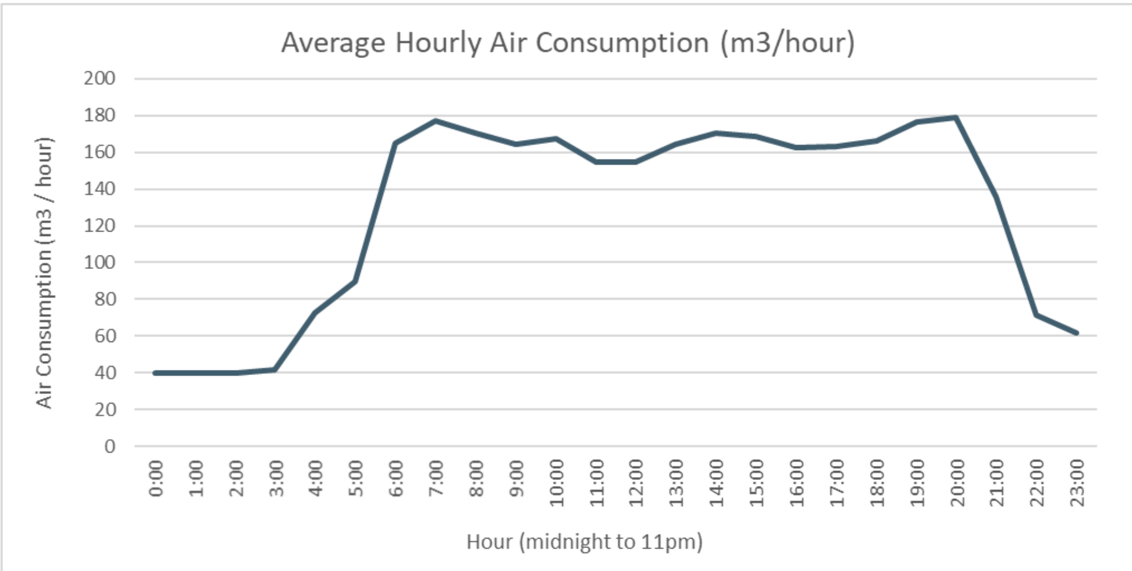
Consumption

Understanding when compressed air use occurs can provide insights into how its usage can be improved or eliminated particularly if specific processes occur at designated times during each day.

Daily consumption (see graph on next page) is relatively even each day indicating that production levels are consistent. There is a slight increase towards the end of the week and weekend usage is lower.

Hourly consumption (see graph on next page) shows the increase in demand around 5am and dropping back around 9-10pm. It is believed this is consistent with the site operation. It is not understood what demands require the system to be operated overnight. If possible, these should be investigated and eliminated.


Average Daily Air Consumption (m3/day)
Air Consumption (m3 / day)
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Sunday
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday
Day of the Week


Average Hourly Air Consumption (m3/hour)
Air Consumption (m3 / hour)
200
180
160
140
120
100
80
60
40
20
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Hour (midnight to 11pm)

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