Close Holes and Openings in Buildings, such as Broken Windows (Louvers) (Arc 2.7444)

(The analysis below was extracted from one of the assessment reports by the Clemson University Industrial Assessment Center (IAC). This is only an example recommendation and hence, not all the background information and sources for numbers are included here.)

Est. Electric Consumption Savings	= ***2903.04 kWh/yr***
Est. Electric Consumption Cost Savings	= ***$139.35 /yr***
Est. Implementation Cost	= ***$900.00***
Simple Payback Period	= ***78 months***

Recommended Action:
It is recommended the louvers on the exhaust fans remain closed when necessary to prevent air leakage, thus reducing the load on the HVAC system and reducing the energy cost.

Background:
The building has 6 exhaust fans that each have 20.25 square feet totaling 121.5 square feet. All the fans have louvers to control the amount of exhaust through the fans when the fans are running. When the fans are off, the louvers should be closed to make sure no significant air loss from the building occurs. During the winter months, hot air is lost to the environment and cold air is lost during the summer months.

The louvers currently on the fans are possibly broken or have not been updated to allow a smooth transition from open or closed.

Anticipated Savings:
This recommendation assumes the leakage due to the open louvers on the exhaust fans is similar to that of a factory door or window. Energy loss is a function of the surface area of the fan opening, the indoor/outdoor temperature difference and the level of louver opening. Louvers at 100% open provide a high amount of exhaust, but when left open when the fans are not running would result in energy loss. The following equation is used to model air leakage in doors and windows. When the louvers are open, and the exhaust fans are off, the "hole" left for air to pass through is like a small factory door being left open. This equation assumes an annual temperature difference around 7°F which is representative for both the difference in the summer months when losing cool air and winter months when losing warm air along with the difference in the spring and fall months.

The estimated unit electricity consumption saving per degree Fahrenheit annually can be determined as follows

Equation 1: Unit Electricity consumption savings (UECS).

$$(UECS) = H = 1.08 \times B \times A \times (t_{in} - t_{out})$$

Where:

H = heat loss [Btu per hour]
1.08 = specific heat of air times density of outdoor air [constant]
A = Area of opening [sq. ft]
T_{in} = Indoor temp [°F]
T_{out} = Outdoor temp [°F]
B = CFM (Leakage) [rate per sq. ft] 4.0 from *Table 6.1 of Infiltration through windows and doors - Handbook of energy audits for a small factory door*

UECS = 1.08 × 4 × 121.5 × 7 = 3674.16 Btus per hour (includes all fans) = 1.08 kW

Equation 2: Electricity consumption savings. This equation assumes the fan louvers are open all the time and uses the previously calculated energy loss per hour. The assumptions provide an upper limit of the possible energy loss.

ECS = UECS × 7 days/week × 16 weeks/yr × 24 hours/day

ECS = 1.08 kW × 7 days/week × 16 weeks/yr × 24 hours/day = 2903.04 kWh/yr

Equation 3: Electric Cost Savings**.**

ECCS = ECS × PK/kWh

Where:

ECCS = Electric Consumption [$]
PK = Average on and off-peak rates [$]

(ECCS) = 2903.04 × ($0.048/kWh)

ECCS = 139.35 $/kWh

<u>Implementation Cost</u>:
Implementation cost will depend on the current state of the louvers and whether they need to be replaced. At current pricing, new louvers for 54 in fans are an average $150 each depending on the material and the maker. The galvanized steel version (found online) is an adequate benchmark which costs $150 each. Assuming all 6 of the exhaust fans need new louvers, the total capital implementation cost would be approx. $900.00.

Implementation Cost (IC) = $900

<u>Simple Payback Period</u>:
The simple payback period is determined by dividing the implementation cost by the annual electrical cost savings.

$$SPP = \frac{IC}{ECCS} \times 12\ months/yr.$$

$$SPP = \frac{\$900}{\$139.35} \times 12\ months/yr.$$

SPP = 78 months

This simple payback period for adding louvers would be an estimated 30 months, given all 6 of the louvers need replaced.