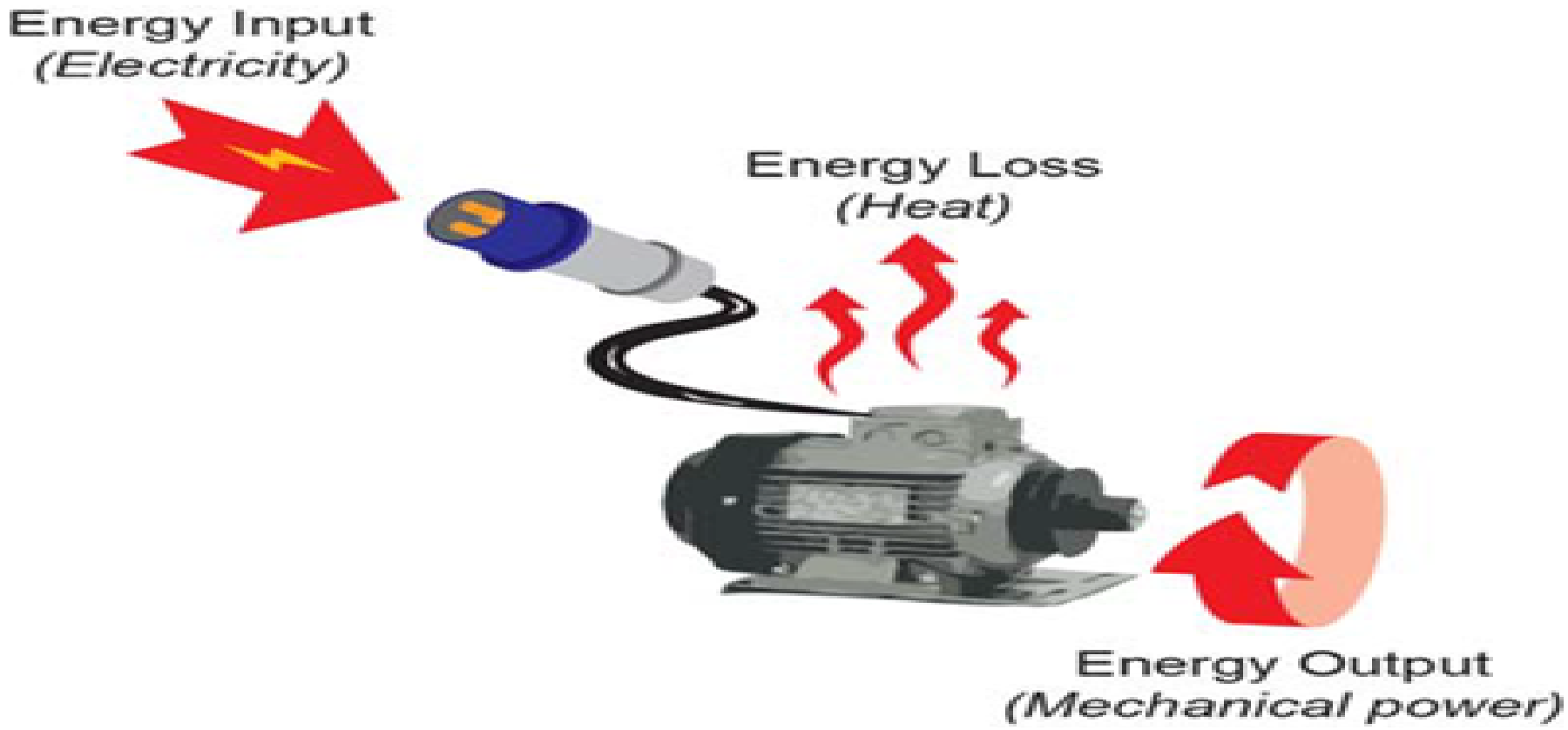
Thermography based Predictive Energy Management practices.

- Energy Auditing Practices using the Thermal Imager in the industry areas, especially in the Electrical Prime Mover Systems in the field, Process flow trains in the Production and utility,

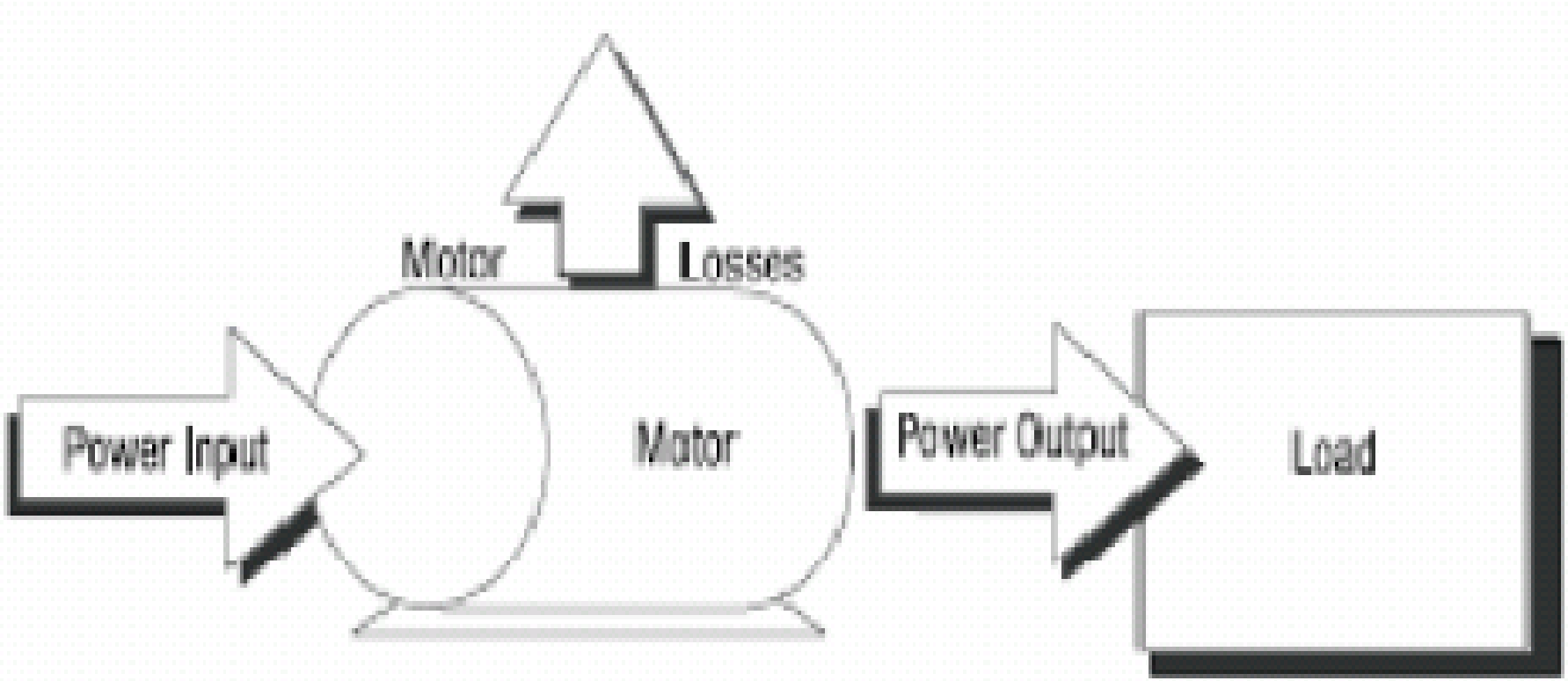
- Machine condition monitoring as a System.
- Energy & Raw Material given in the Input
- And energy & product delivered in the output
- & Energy & Material in Exhaust, wasted areas

Heat is a symptom of motor loss
Cold Running motor is under-loaded and energy loser.
Warm motor is healthy in many aspects, energy rightly used.
Hot motor is not at all healthy, likely to burnout,
and energy loser. Where Safety fails, Conservation Fails.

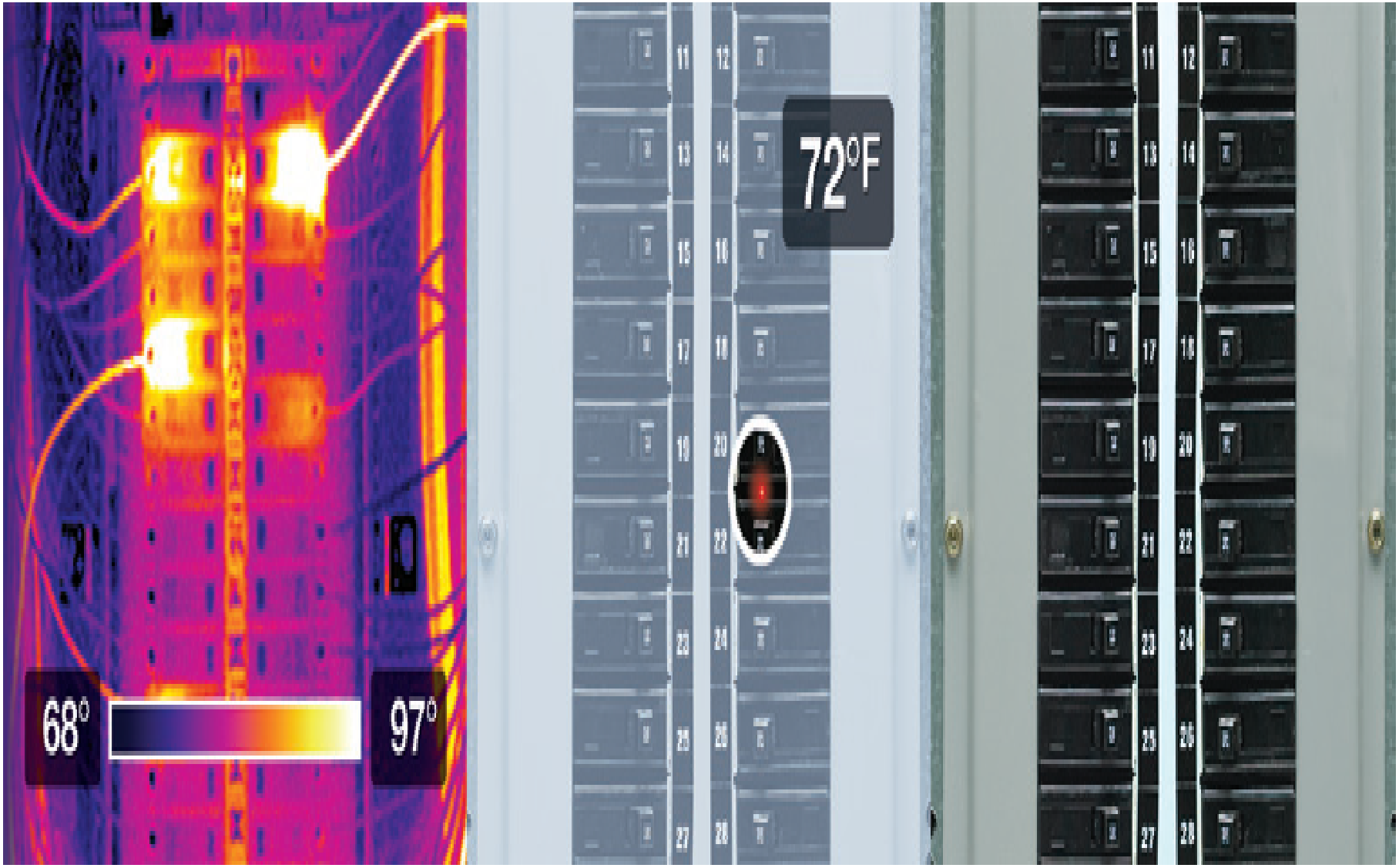


Motor input = Motor Output + Losses

Motor rating is defined by its Mechanical shaft output in KW and its Electrical Power input in KW is always much more than Motor rating KW.



THERMAL IMAGING VIEW –
INFRA RED VIEW GUN –
HUMAN EYE VIEW

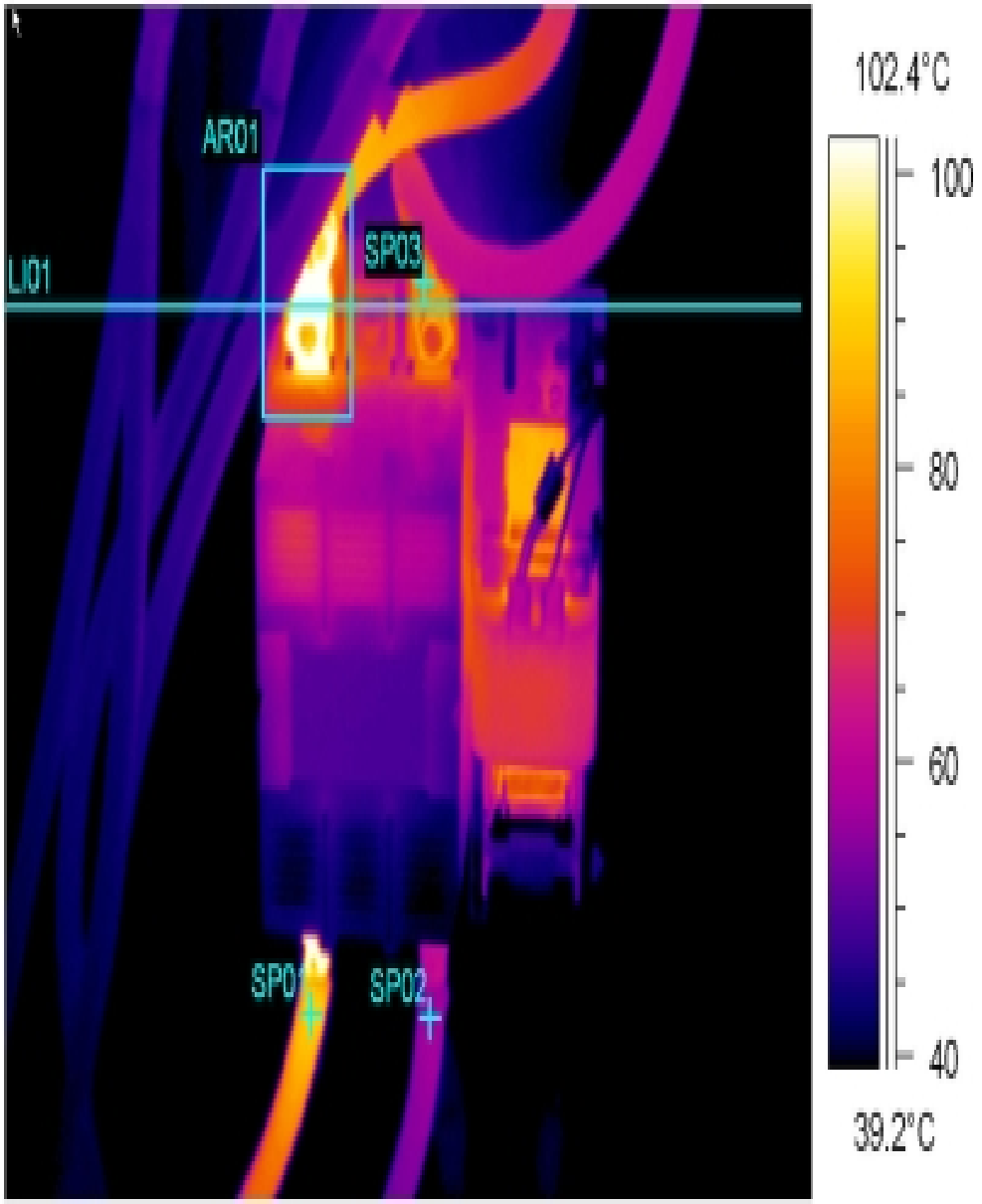


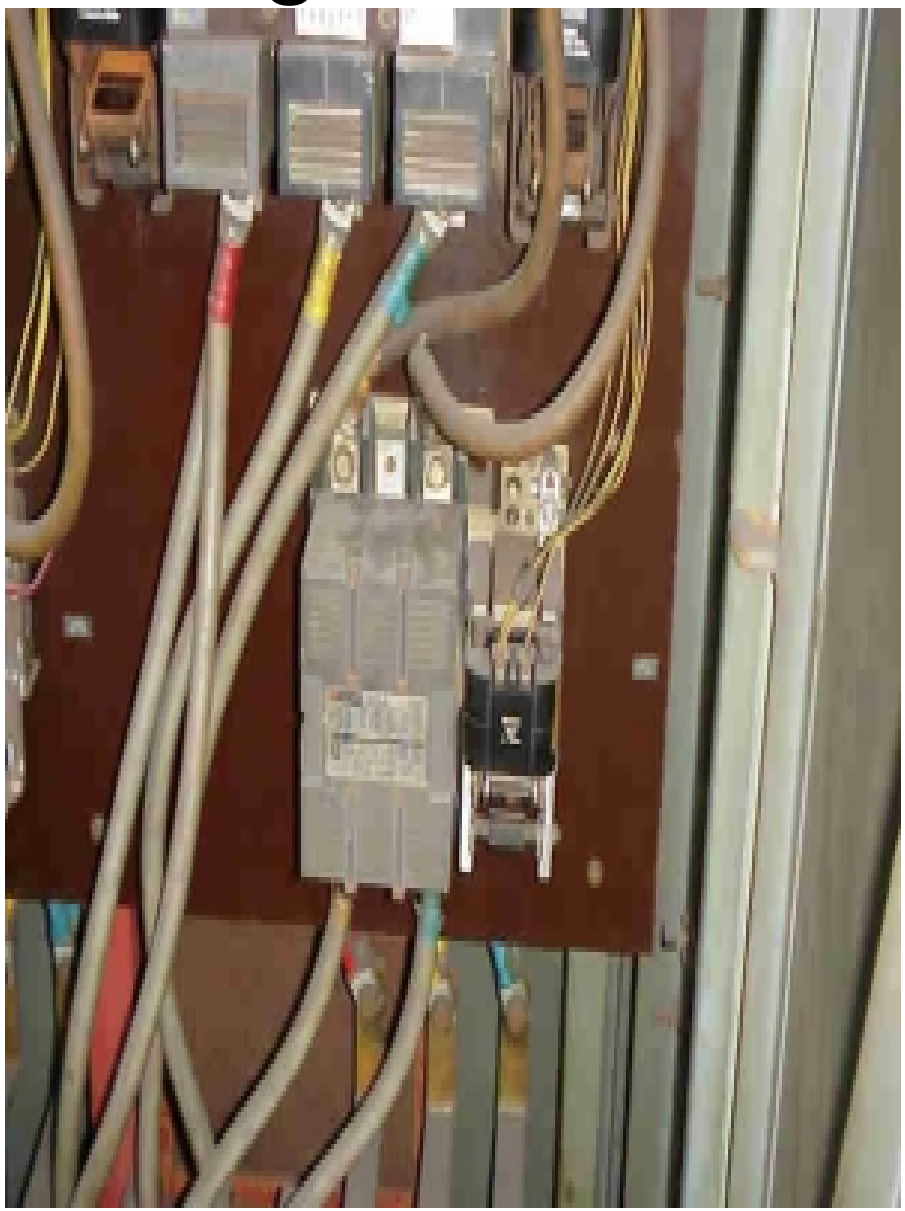
Emissivity of the surfaces is critical and prone to false reading when using thermal imager.

Table 6-2: Coefficients A, B for estimating 'h' (in W/m^2-K)

Surface	ε	A	B
Aluminium , bright rolled	0.05	0.25	0.27
Aluminium, oxidized	0.13	0.31	0.33
Steel	0.15	0.32	0.34
Galvanised sheet metal, dusty	0.44	0.53	0.55
Non metallic surfaces	0.95	0.85	0.87

Thermal Imaging – Tool to Predictive Maintenance – Management

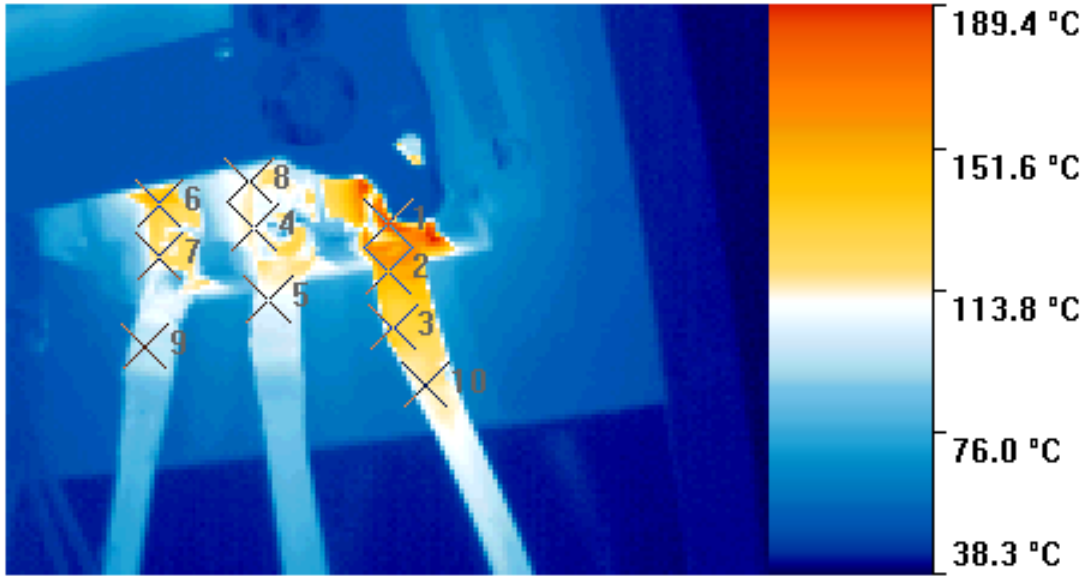




Testo 880 IRSoft

File Edit View Options Help

Scale	
Min [°C]	38.3
Max. [°C]	189.4
Automatic	OK
Palette	
Palette	Blue/red
Limit values	
Active	☐
Isotherm	
Active	☐
Picture settings	
Emissivity	0.95
Reflected	20.0
Humidity	50.0
Ambient t	20.0
Dewpoint	9.3
Diagram setting	



-20.0 °C 350.0 °C

38.3 °C 189.4 °C

#	Temp.	Comments
1	184.1 °C	- image 240
2	148.0 °C	compressor I
3	129.6 °C	outgoing cable from
4	111.2 °C	the Contactor.
5	105.2 °C	
6	134.3 °C	
7	116.8 °C	
8	106.2 °C	
9	95.2 °C	
10	115.2 °C	

Ready NUM

start Wind... Sent ... Fw: p... My D... Testo... 5:08 PM

Thermal Imaging – How to find the abnormal symptoms from the normal parameters?

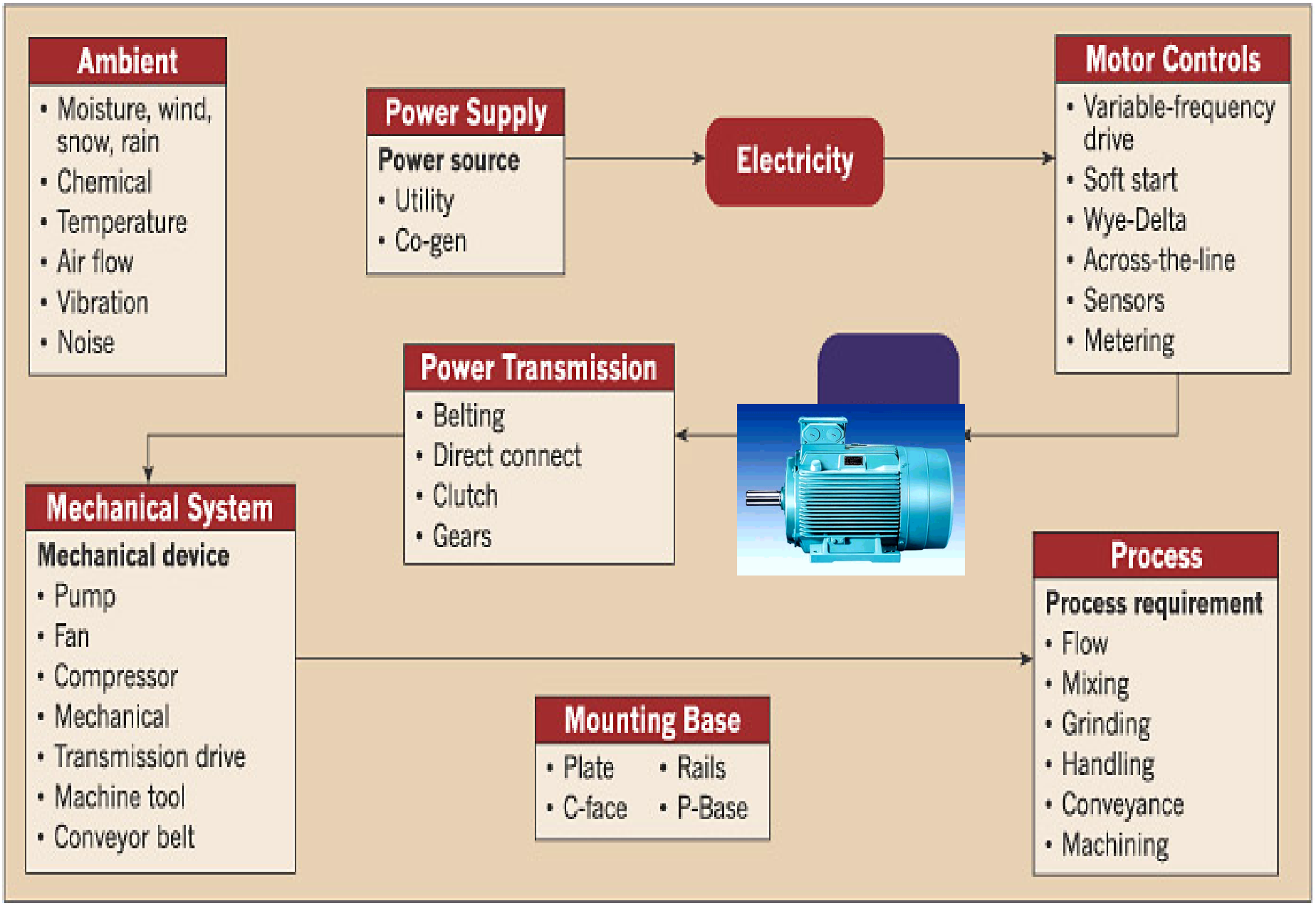
Temperature difference (ΔT) based on comparisons between similar components under similar loading	Temperature difference (ΔT) based on comparisons between component and ambient air temperatures	Recommended action
1 °C to 3 °C	1 °C to 10 °C	Possible deficiency; warrants investigation
4 °C to 15 °C	11 °C to 20 °C	Indicates probable deficiency; repair as time permits
- - - - - -	21 °C to 40 °C	Monitor until corrective measures can be accomplished
>15 °C	>40 °C	Major discrepancy; repair immediately

Table 100.18 *"Thermographic Survey Suggested Actions Based on Temperature Rise"* Courtesy InterNational Electrical Testing Association ANSI/MTS-07

Energy Saving Potential

Sector	Potential(%)
Economy as a whole	Up to 23
Agricultural	Up to 30
Industrial	Up to 25
Transport	Up to 20
Domestic and Commercial	Up to 20

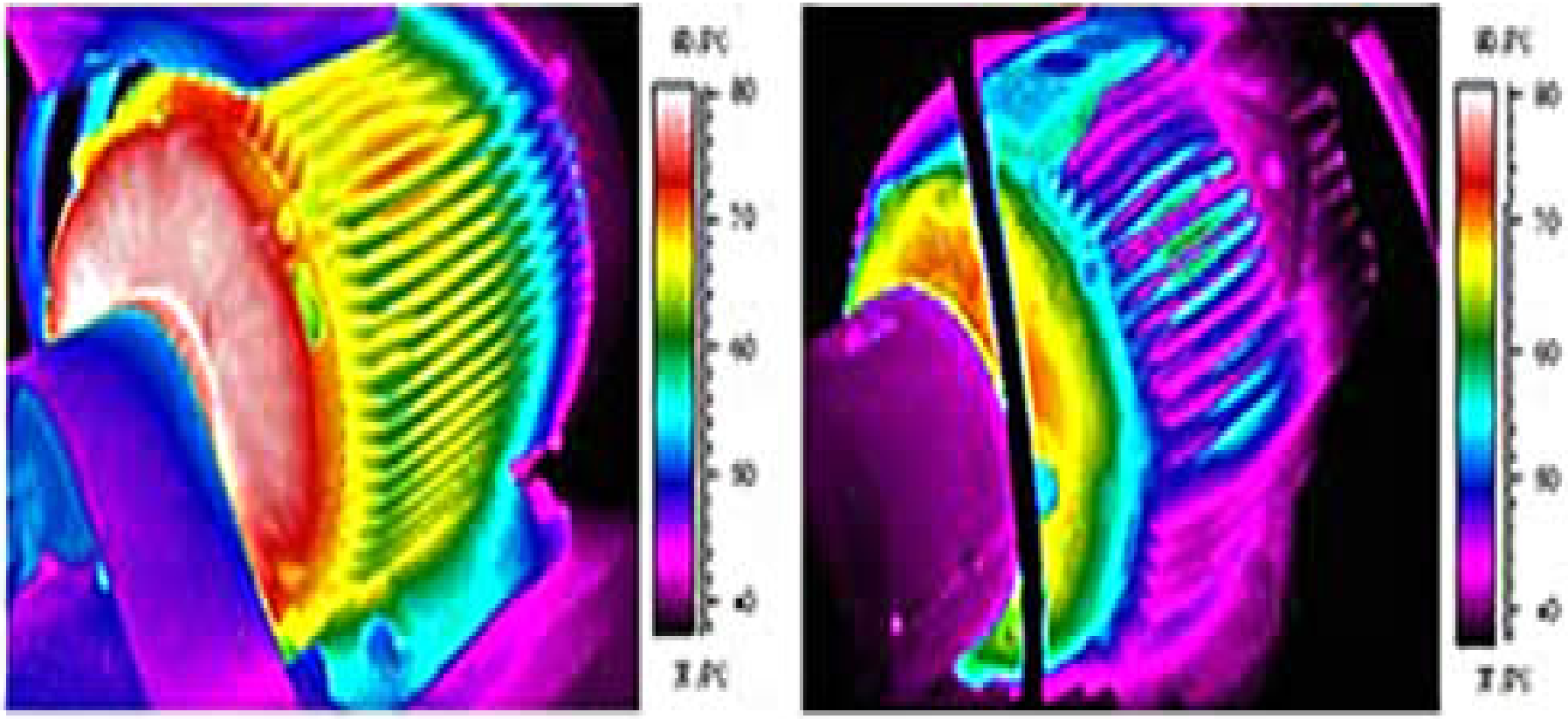
Motor System – Ambient – Input – App – control – process



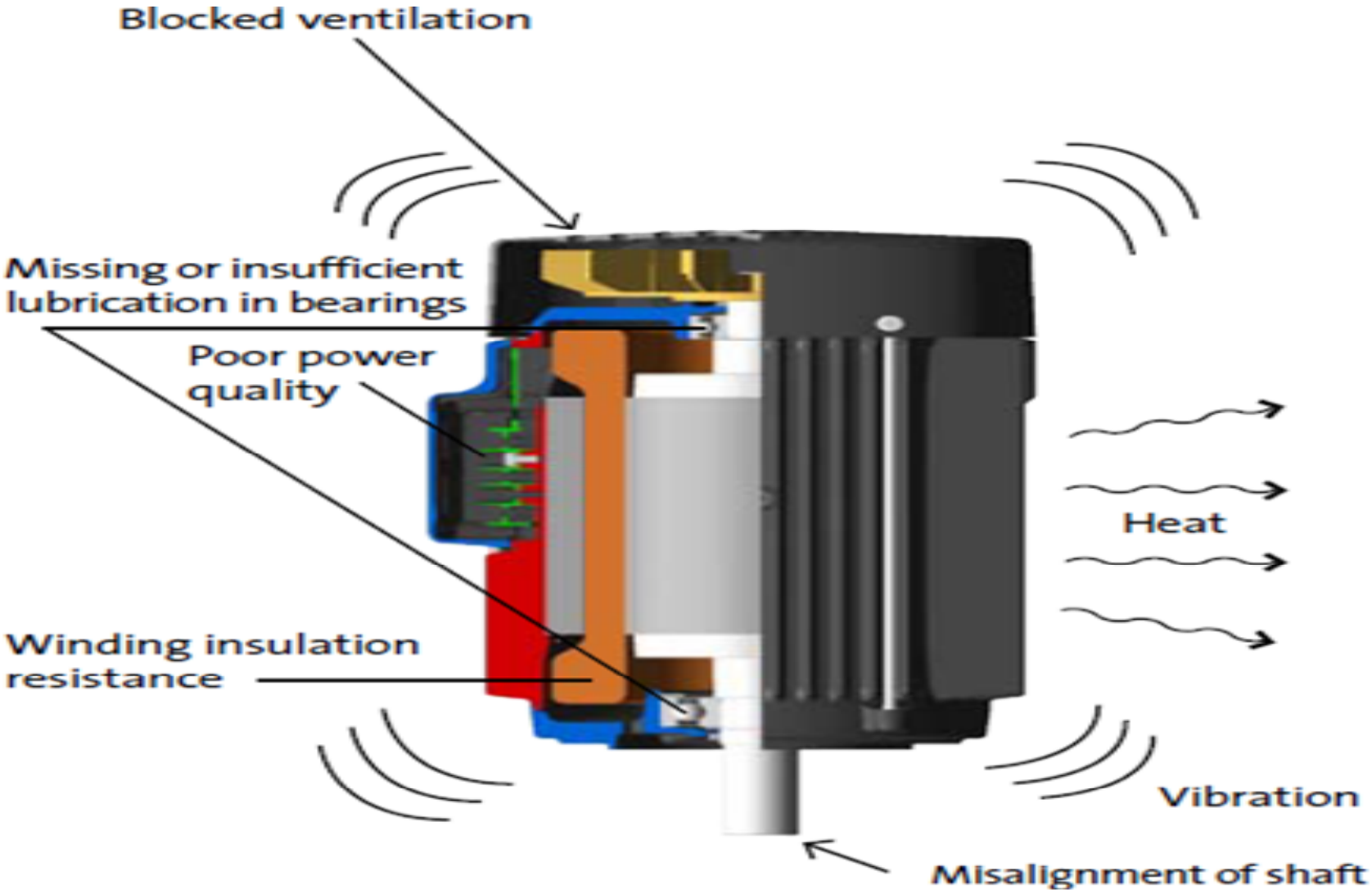
Motor Thermal Imaging

When comparing these two motors,

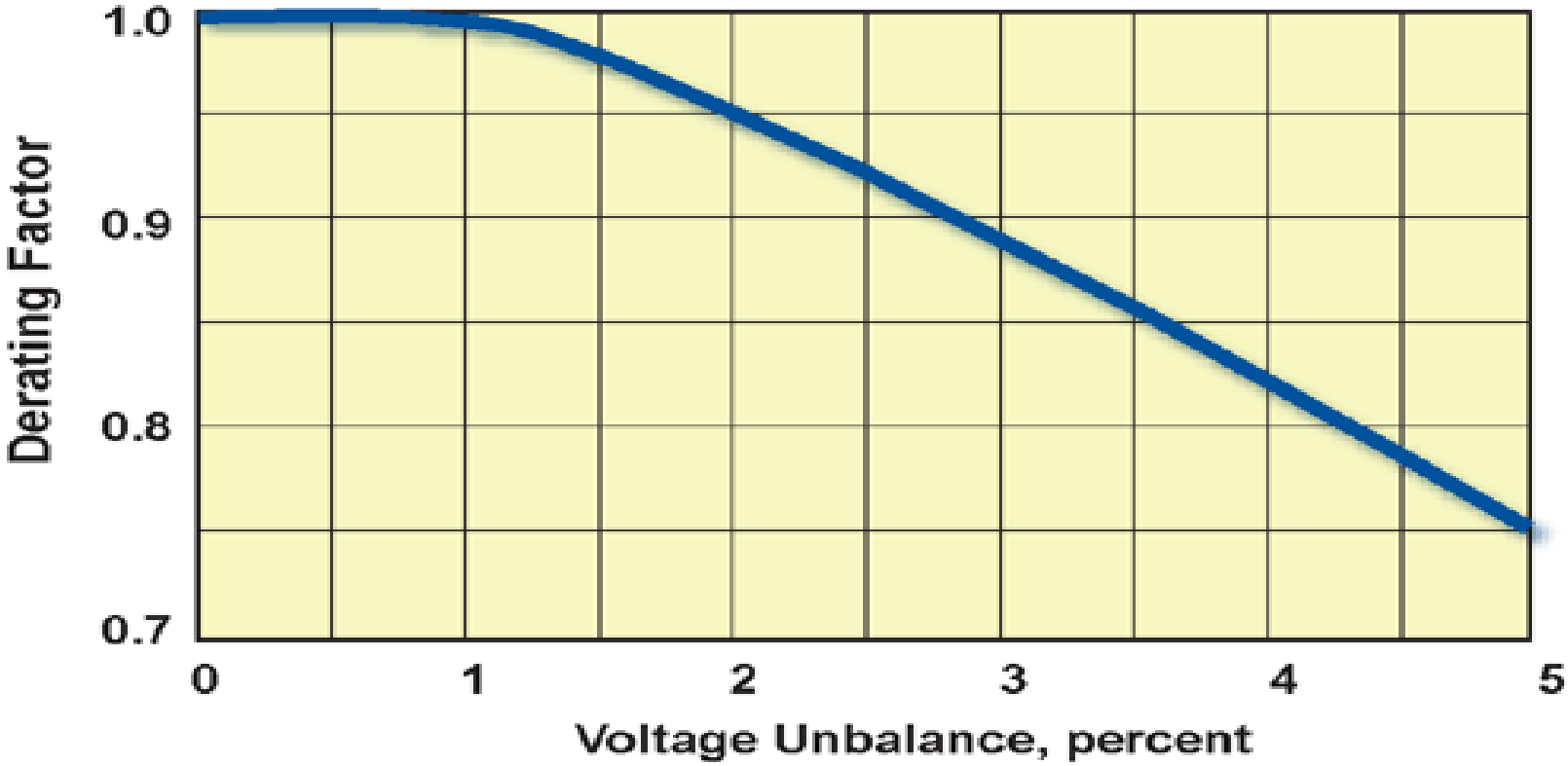
the thermal patterns are similar but there is a marked overall temperature rise on the motor on the left.



Motor life span – Factors affecting the life due to lack of maintenance

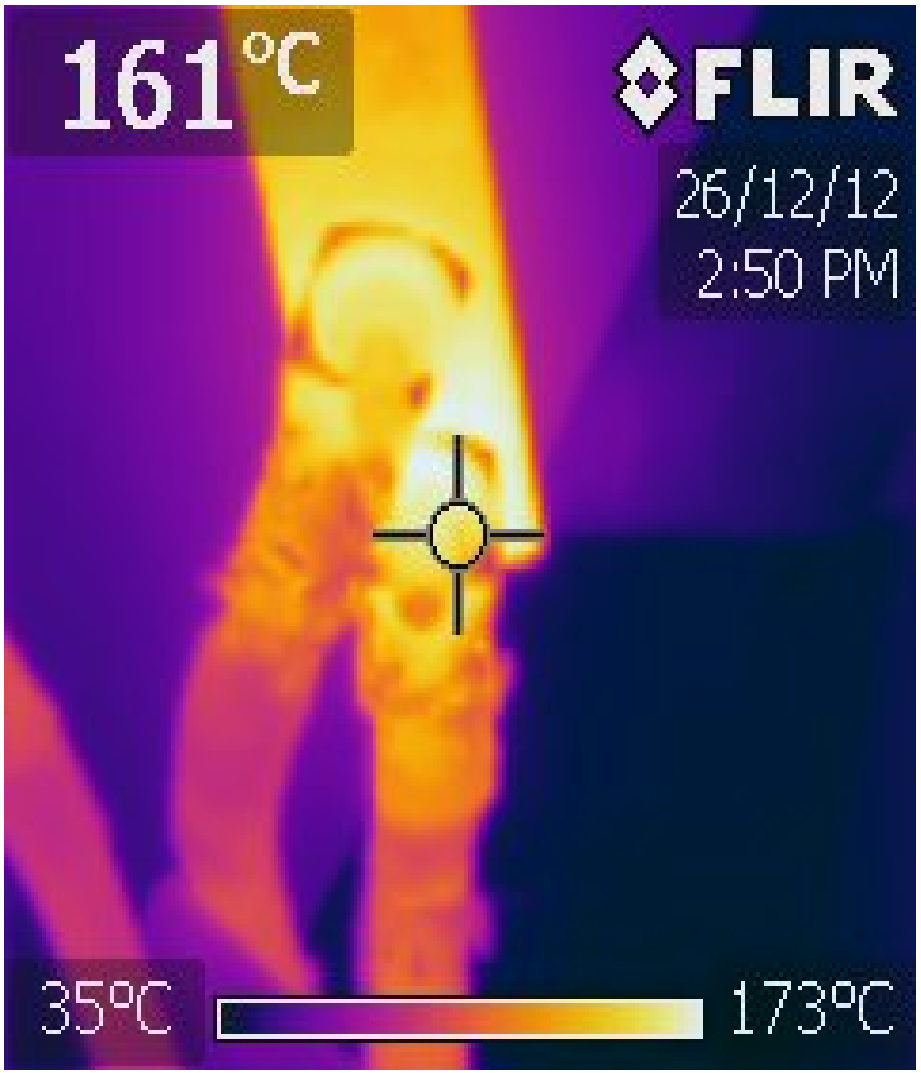


Motor De-rates by 7 % when voltage unbalance is 2.5 % i.e. 390,400,410 volts across 3 phases at motor terminals

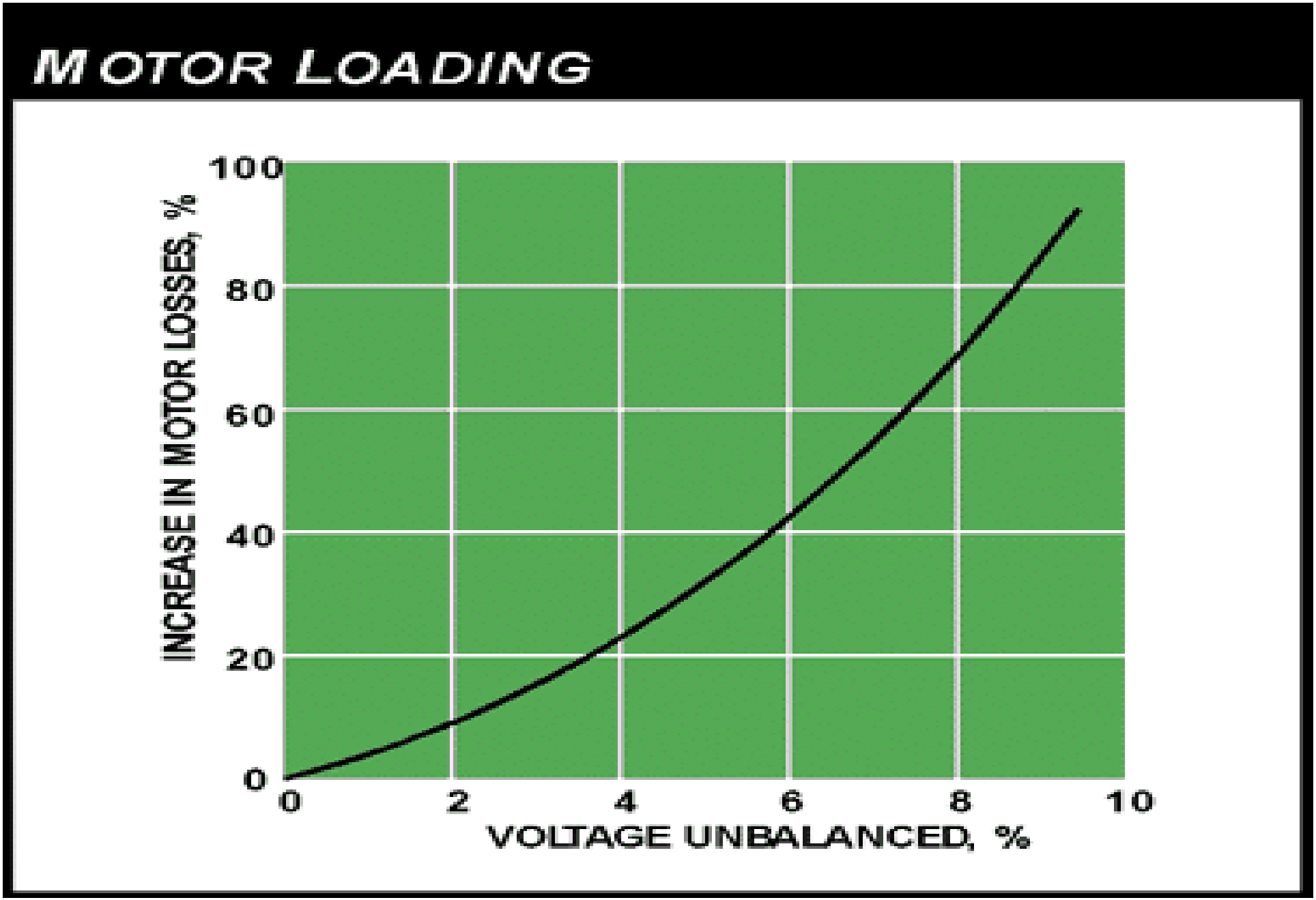


$$\% \text{ Unbalance} = \frac{100 \times \text{maximum voltage deviation from average voltage}}{\text{average voltage}}$$

Motor to fail, shortly due to single phasing. Loose connection in Bus bar leads to volt and current unbalance and efficiency drops.



Voltage unbalance increases, motor loss increases



MOTOR SURVEY Recommendations

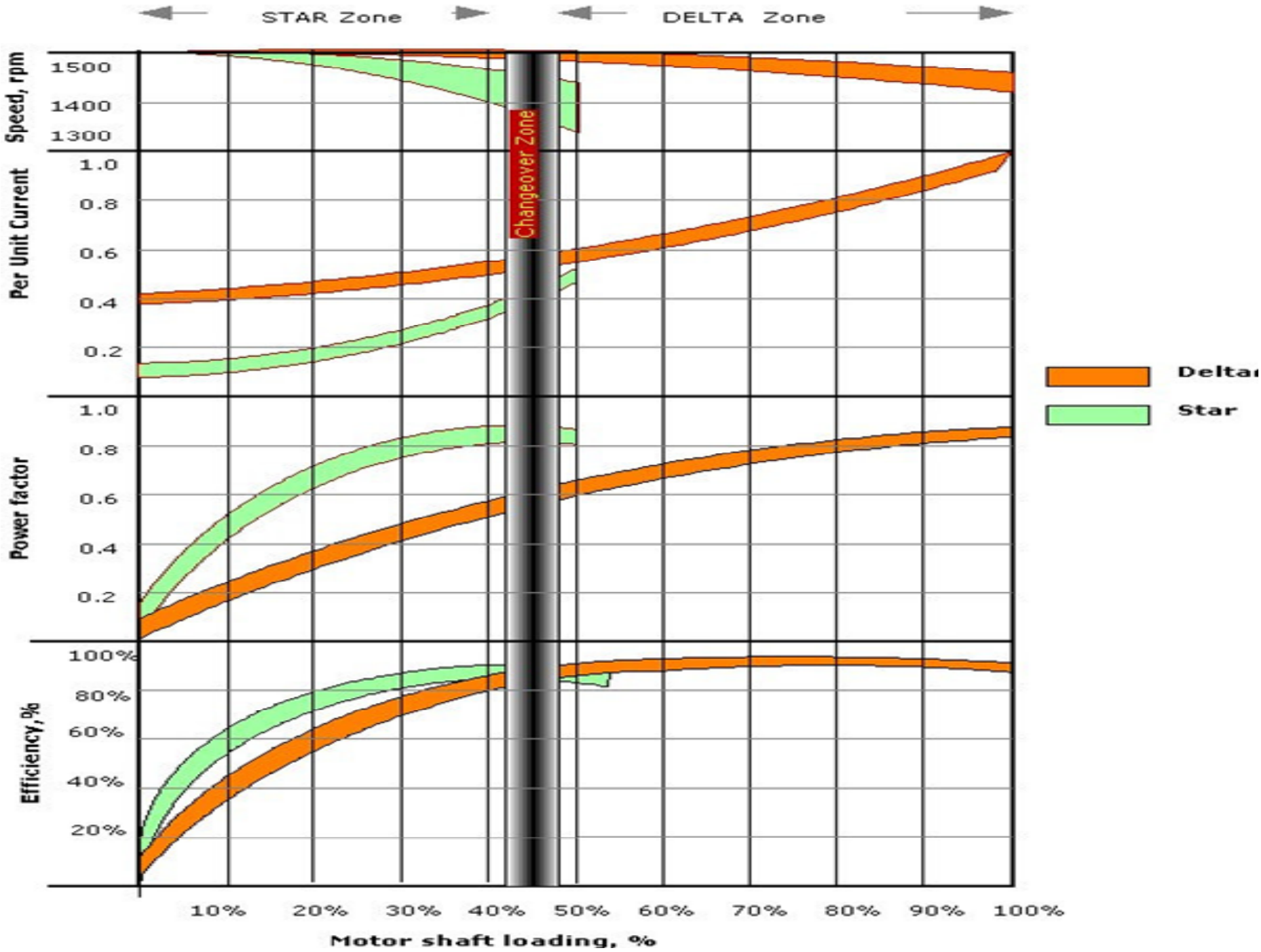
•The following recommendations suggested after motor loading survey in the industry :-

- Identify motors by "Loading Versus Rating" value
  - Below 50 % loading,
  - 50 - 100 % loading,
  - over 100 % loading.

•Identify motors with machine side losses / inefficiencies like idle operations, throttling / damper operations for avenues like automatic controls / interlocks, variable speed drives, etc.

•Replace with smaller size motors.

•Reduce the load on 100% loaded motors or replace with higher size motors.


STAR Zone
DELTA Zone
Speed, rpm
1500
1400
1300
Changeover Zone
Per Unit Current
1.0
0.8
0.6
0.4
0.2
Power factor
1.0
0.8
0.6
0.4
0.2
Efficiency, %
100%
80%
60%
40%
20%
Delta
Star
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Motor shaft loading, %

Motor belt & pulley hotter than motor drive end.

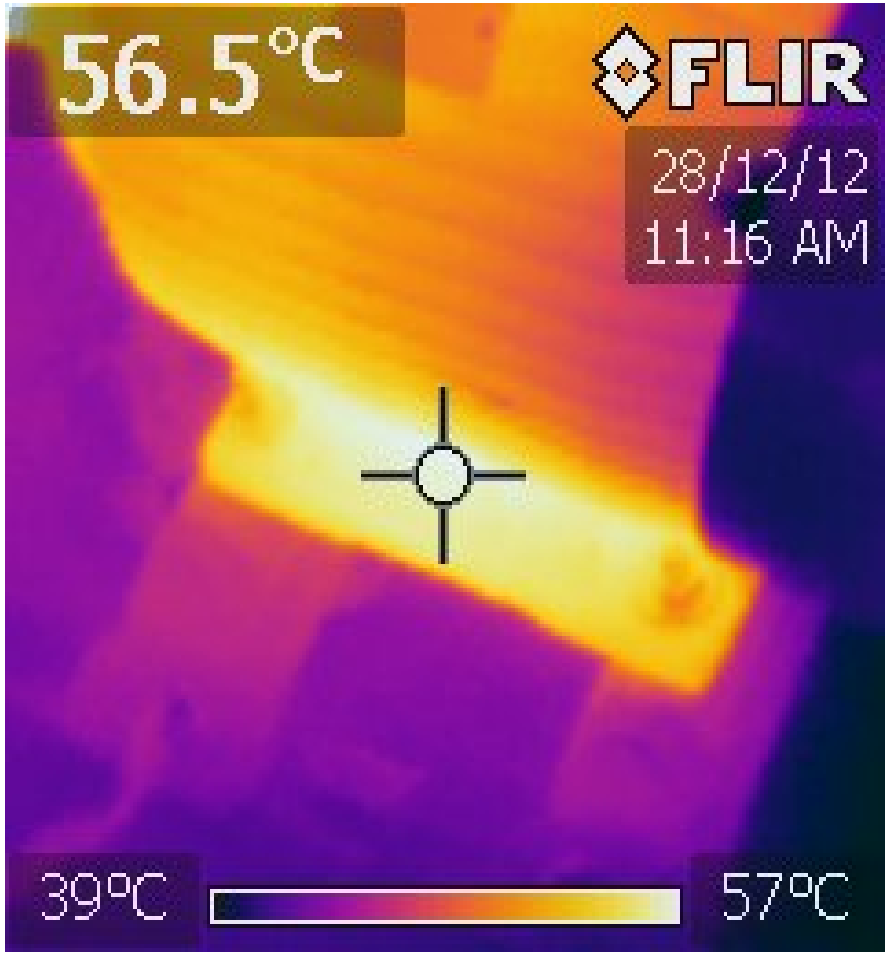
Motor drive transmission efficiency - Visible losses seen in Belt Losses from motor to load

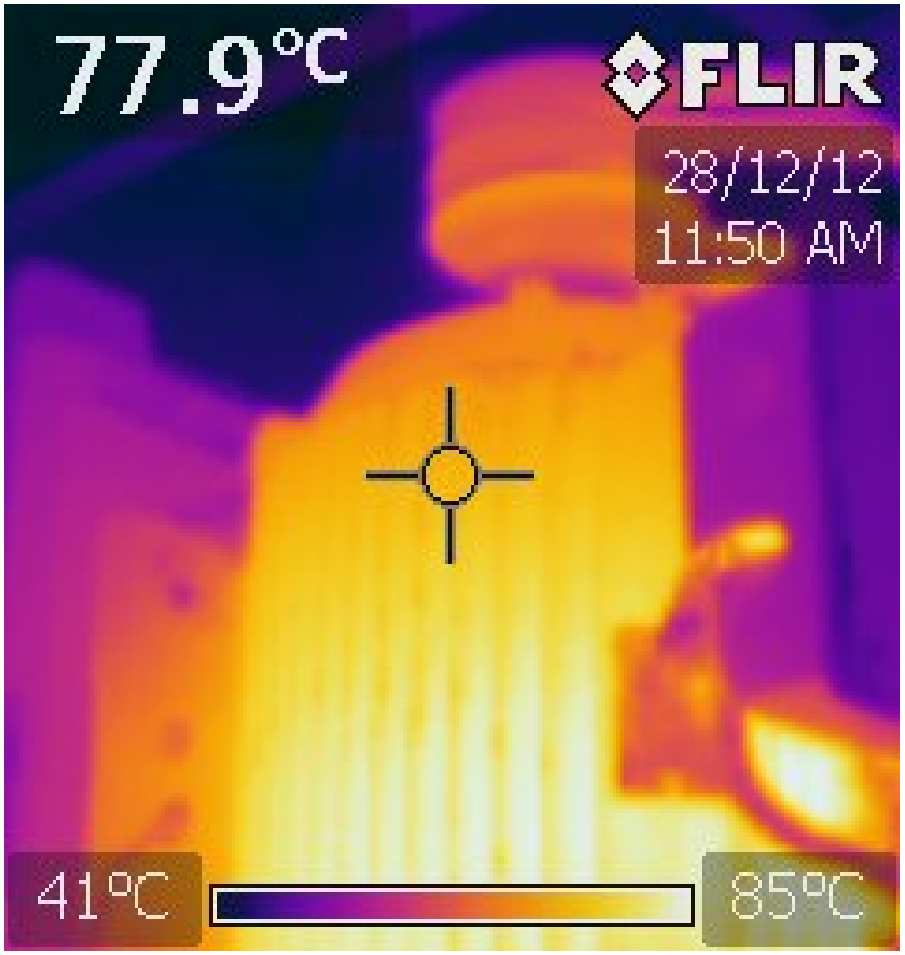
The efficiency of mechanical power transmission depends on grip between pulley and belt, further depends on μ (Co-efficient of friction) and strength (Tensile) of the belt. In case of

Table 3.4: Losses in V Belts

Sr. no.	Motor HP	Losses %
1	2	8-15
2	3	7-13
3	4	6-12
4	6	5.5-10
5	8	5-9
6	10	4.5-8.2
7	20	3.5-7
8	30	3.2-6
9	40	3-5.5
10	60	2.8-5
11	80	2.5-4.5
12	100	2.5-4.5

Motor hotter due to poor ventilation. Motor central skin hotter due to more rewindings done and less efficiency now.





System Energy losses viewed from Input KW to motor

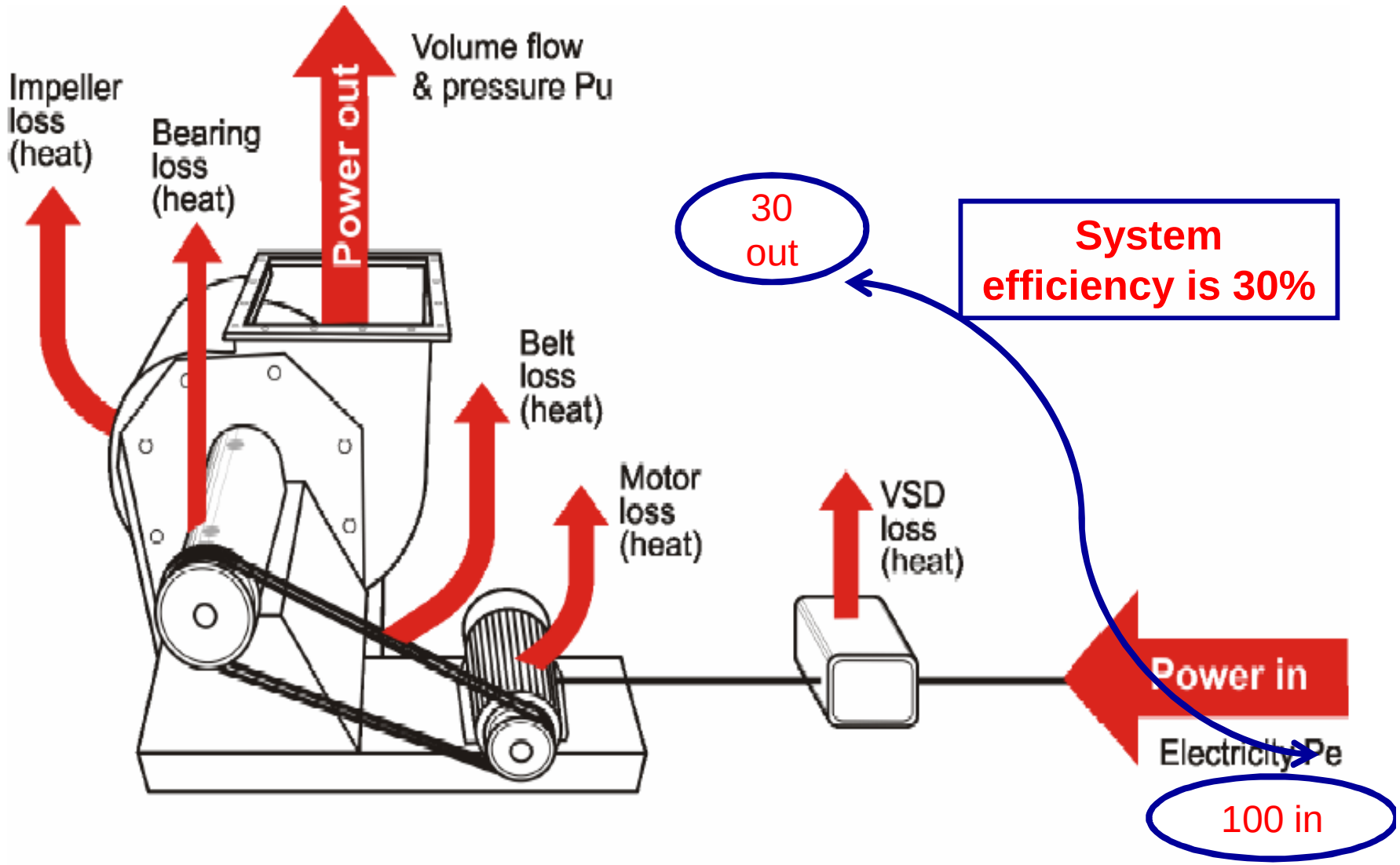
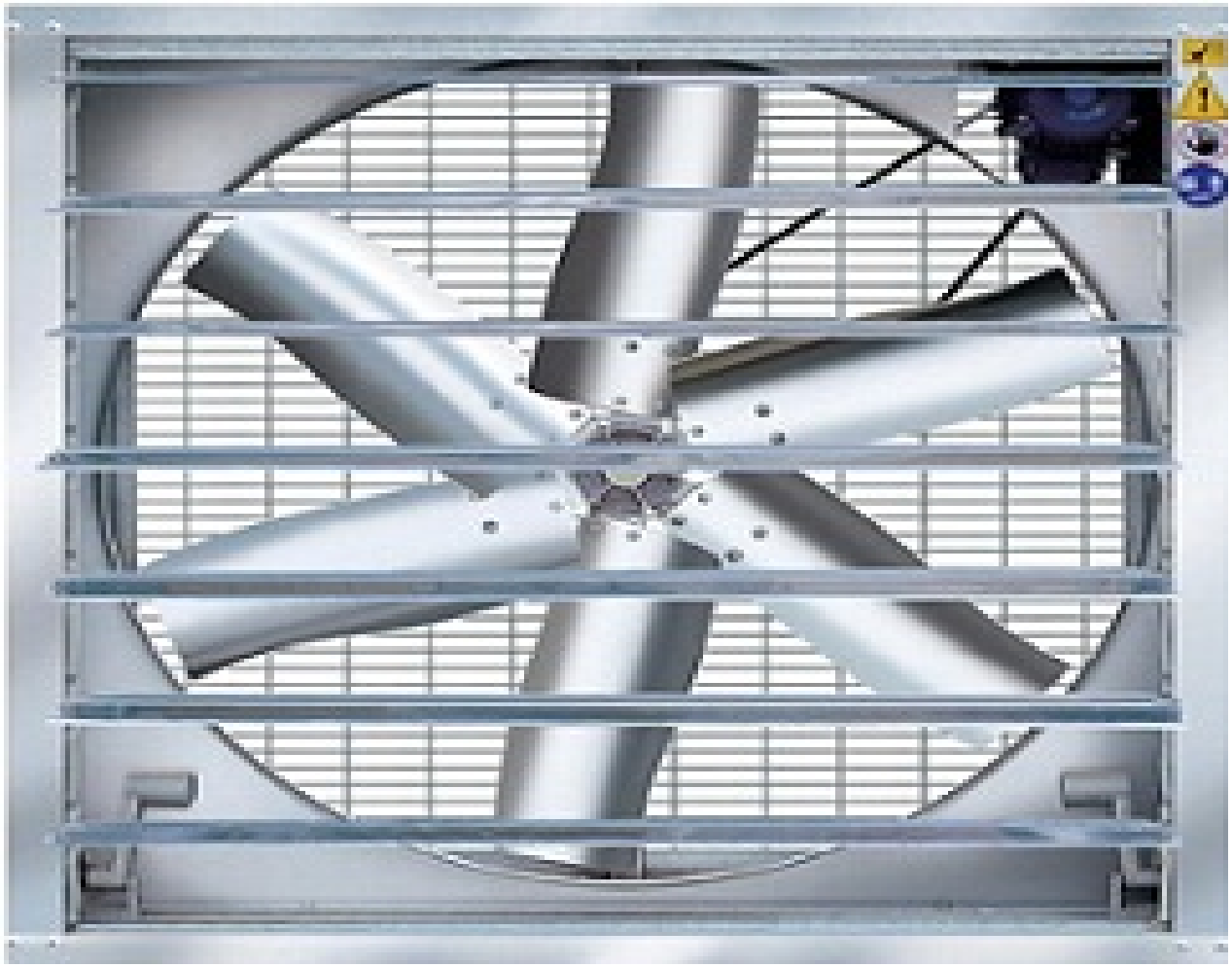
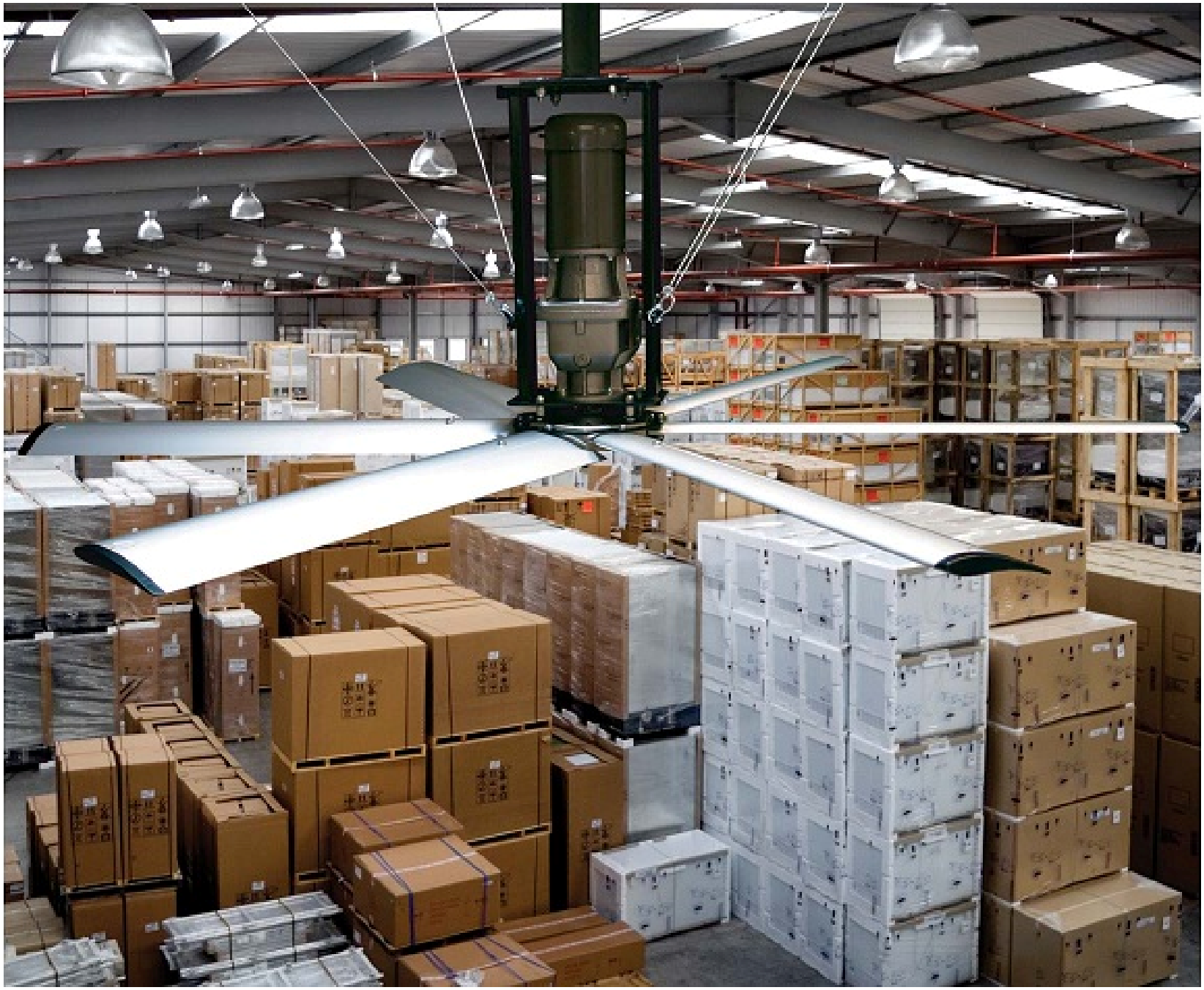


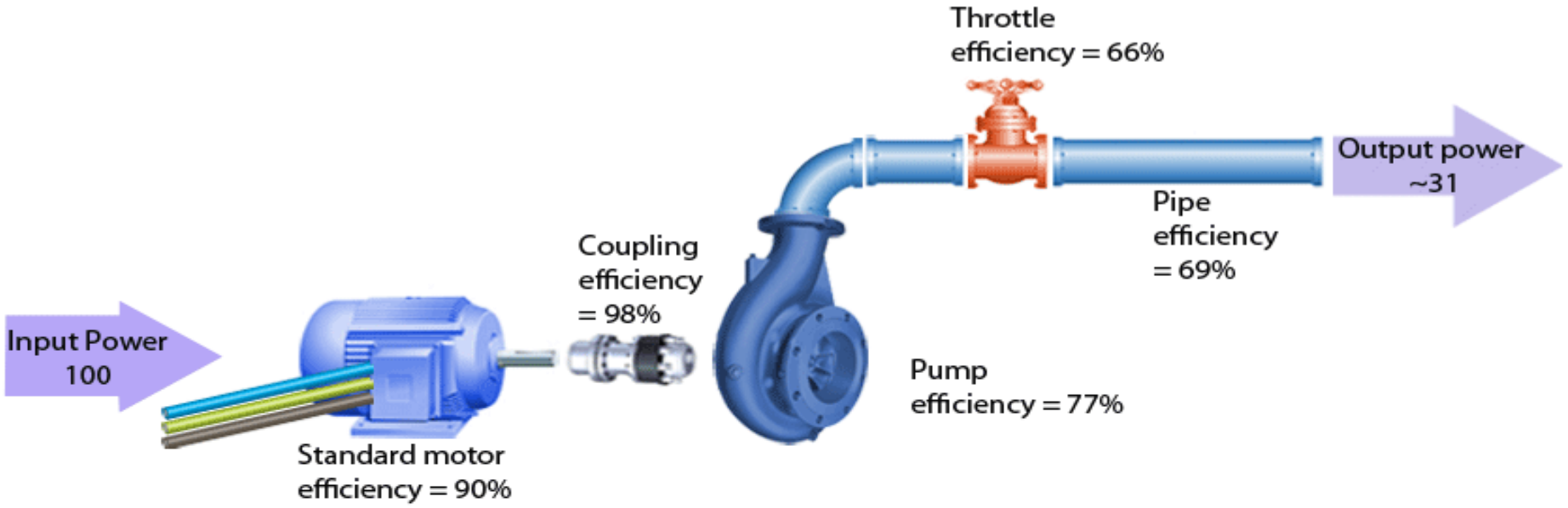
Diagram showing the losses from a fan system including VSD, motor and belt drive.

Vertical High Volume Low Speed Fans costing few Thousand Rs only, but gives Lakhs of CFM consumes only less than One KW. But gives Immense Relief to the workers in harsh ambient industry environments.

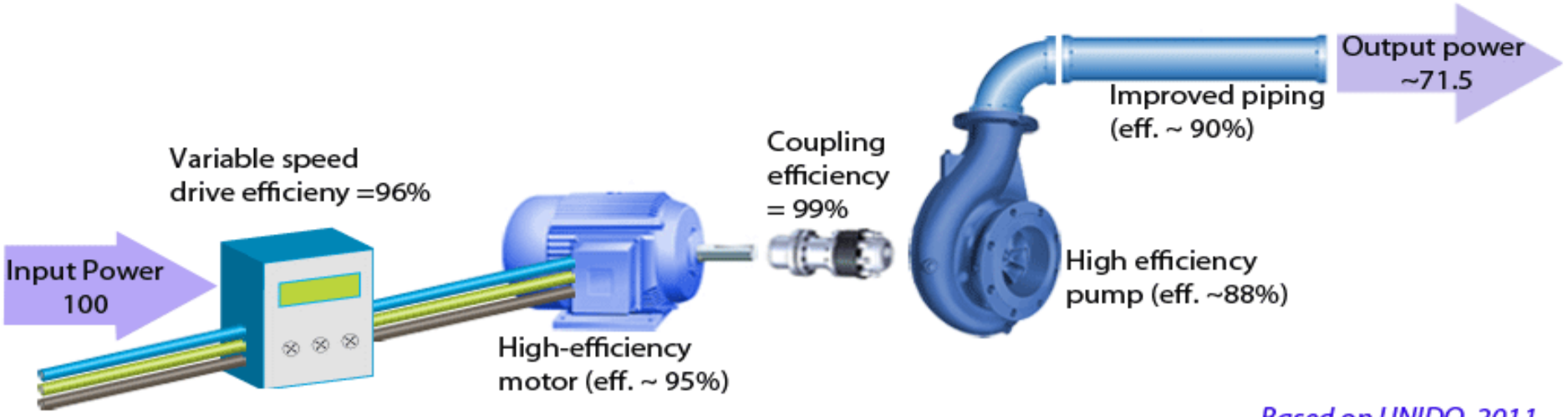




Conventional Pumping System (Efficiency ~ 31%)



Efficiency Optimized Pumping System (Efficiency ~ 72%)

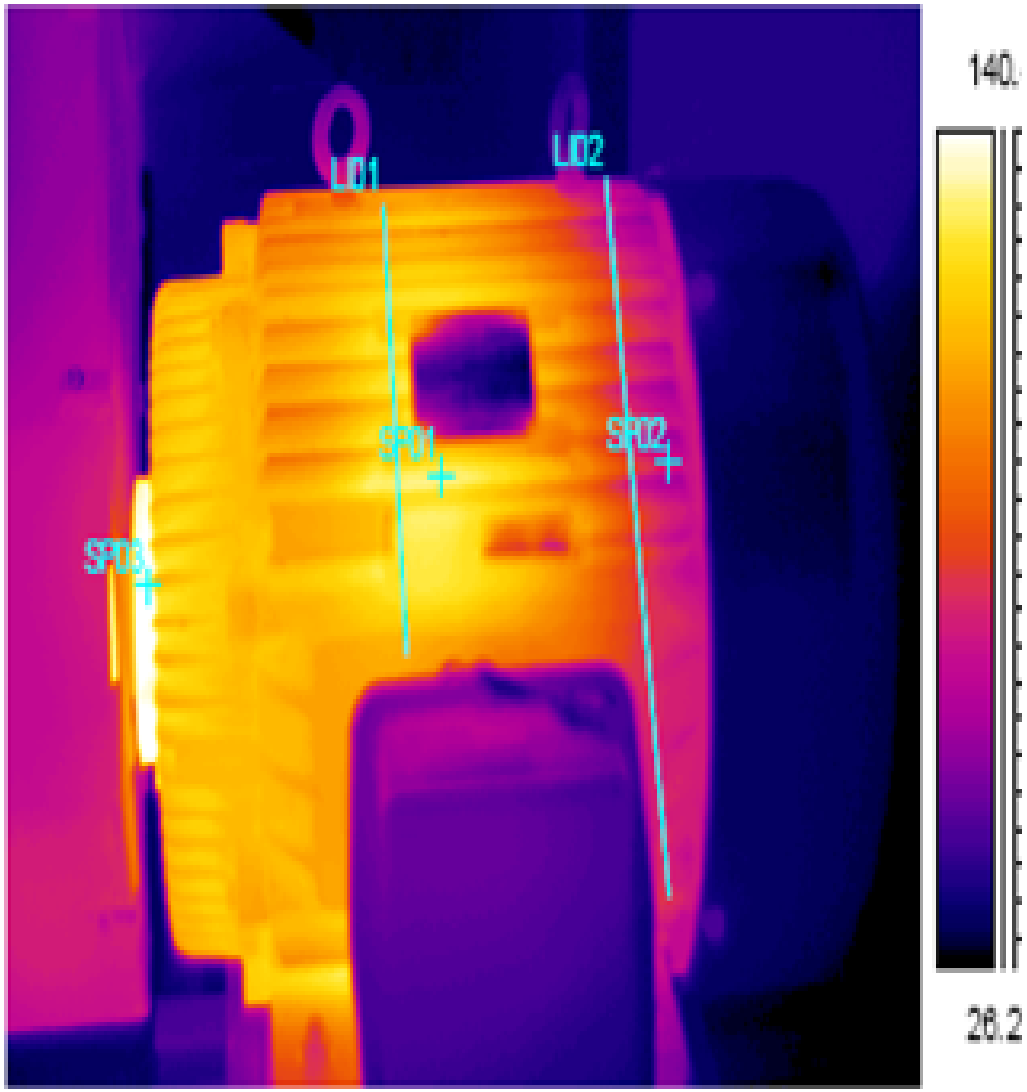


Based on UNIDO, 2011.

Pumping system – savings

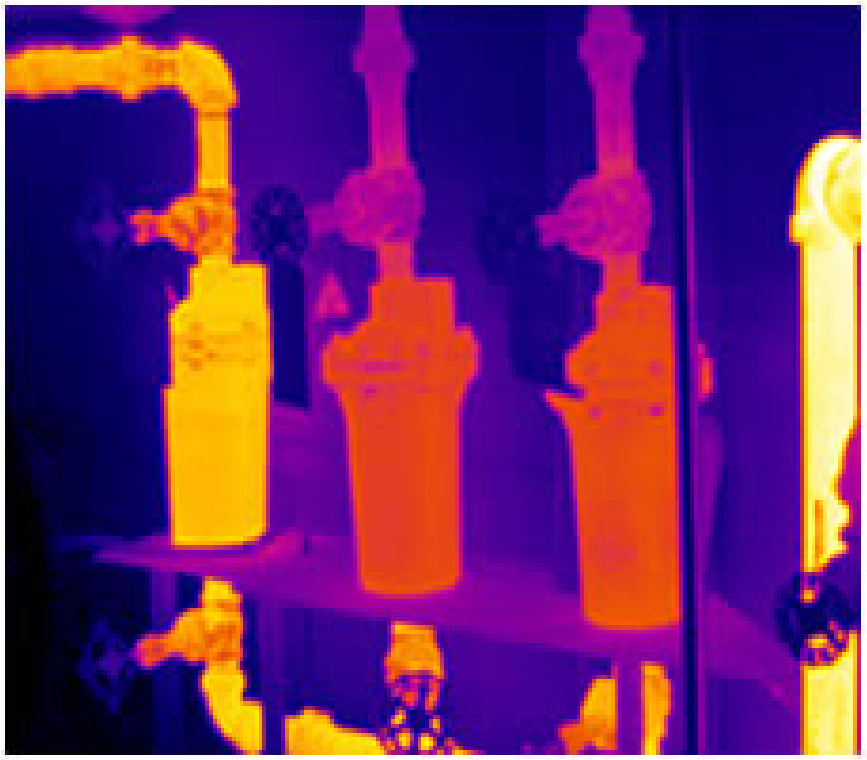
parameters	existing’	new pump
Motor rating hp	**7.5**	**5**
Suction pipe mm	65	75
Delivery pipe mm	50	75
Piping material	GI	White PVC
Foot valve	local	ISI
Discharge LPS	3.68	5.03
Input power KW	**6.18**	**4.35**
Increase in discharge	--	36.7 %
Input power reduction	29.66 %	--
Saving in Energy	**--**	**48.44 %**

Hot spots motor bearing DE & NDE

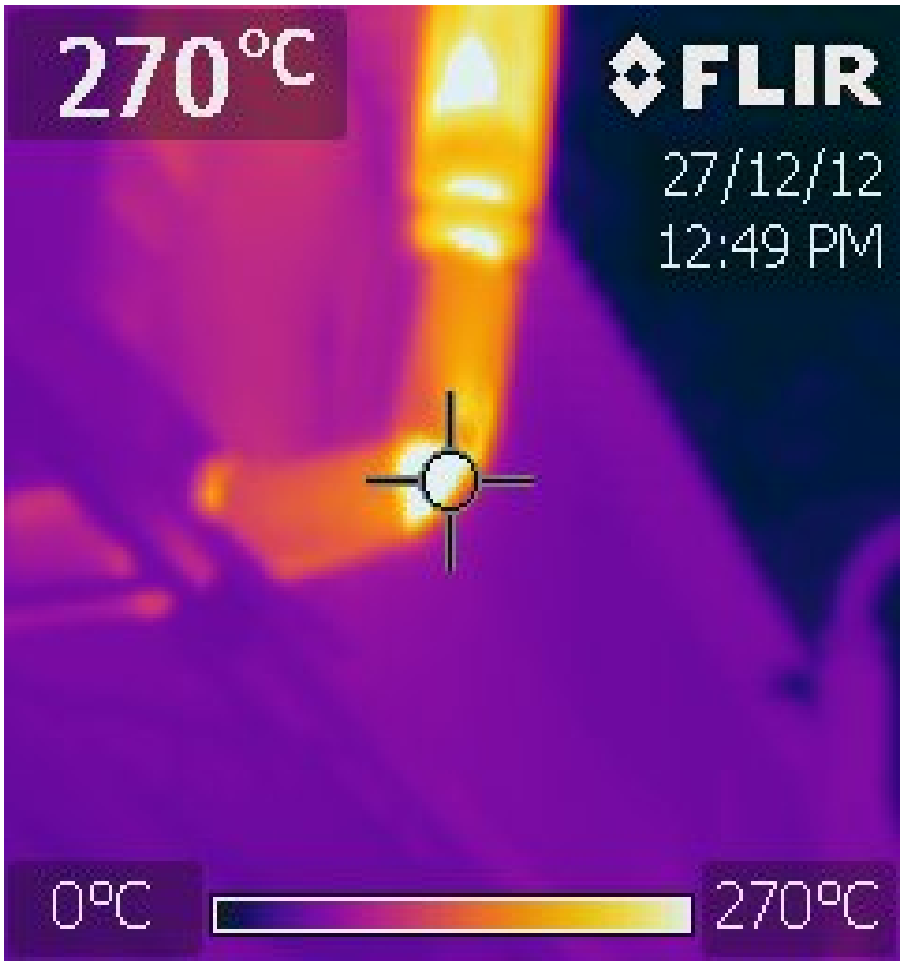


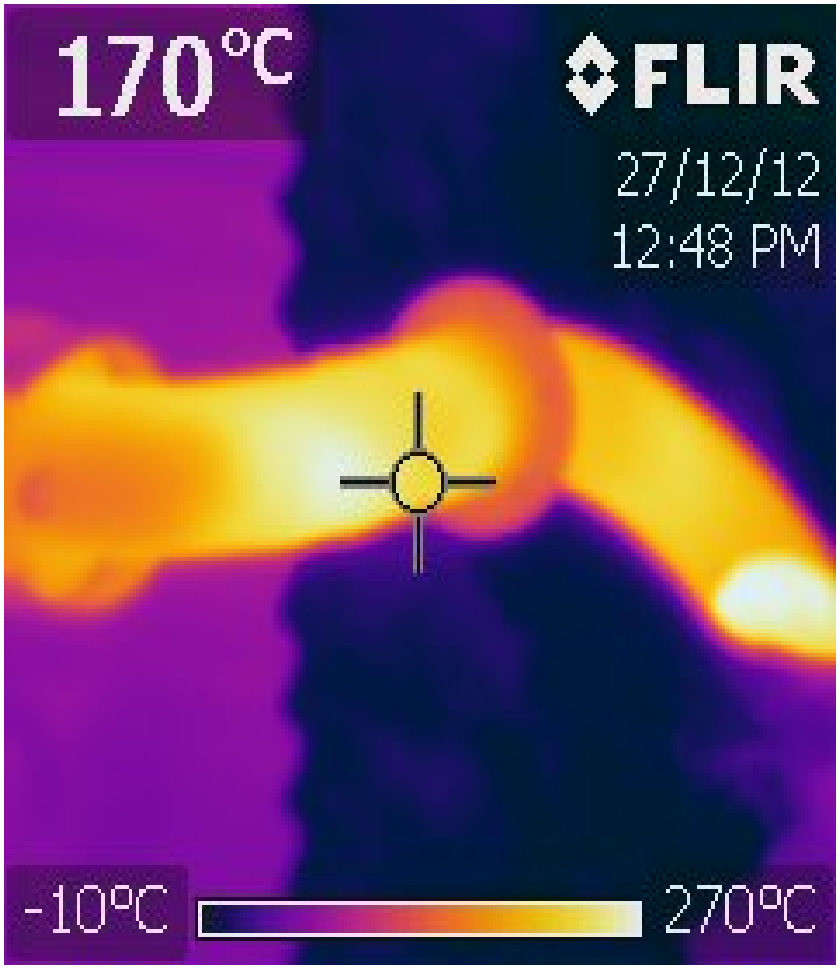
Steam Trap Thermal Imaging points to :-

In these two photos of steam traps, the Infrared Thermal Imaging photo on the left shows the point of leakage.

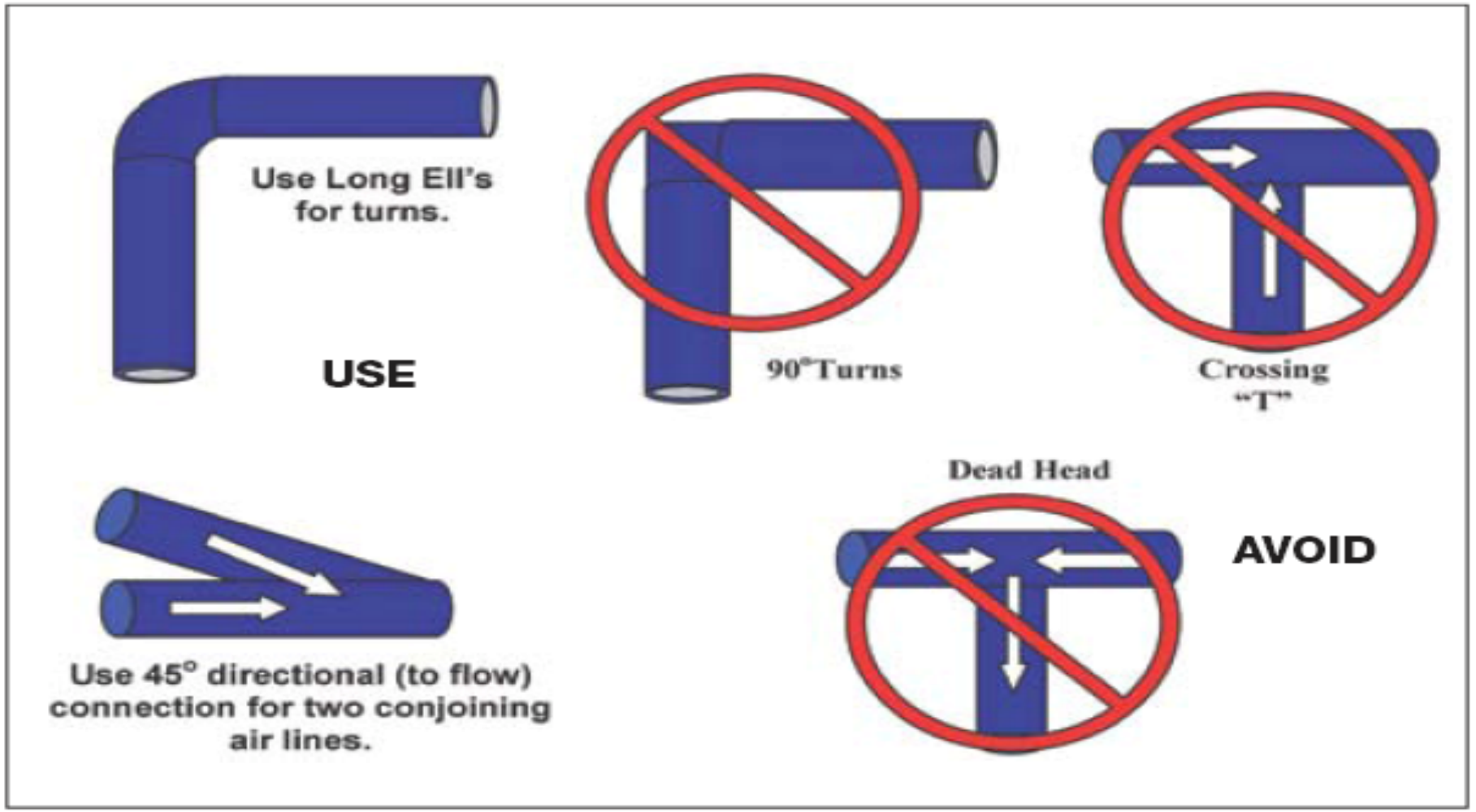


DG sets getting de-rated due to choked exhaust DG was overloading before and tripping. After correction, they could fully utilize DG KVA rating.

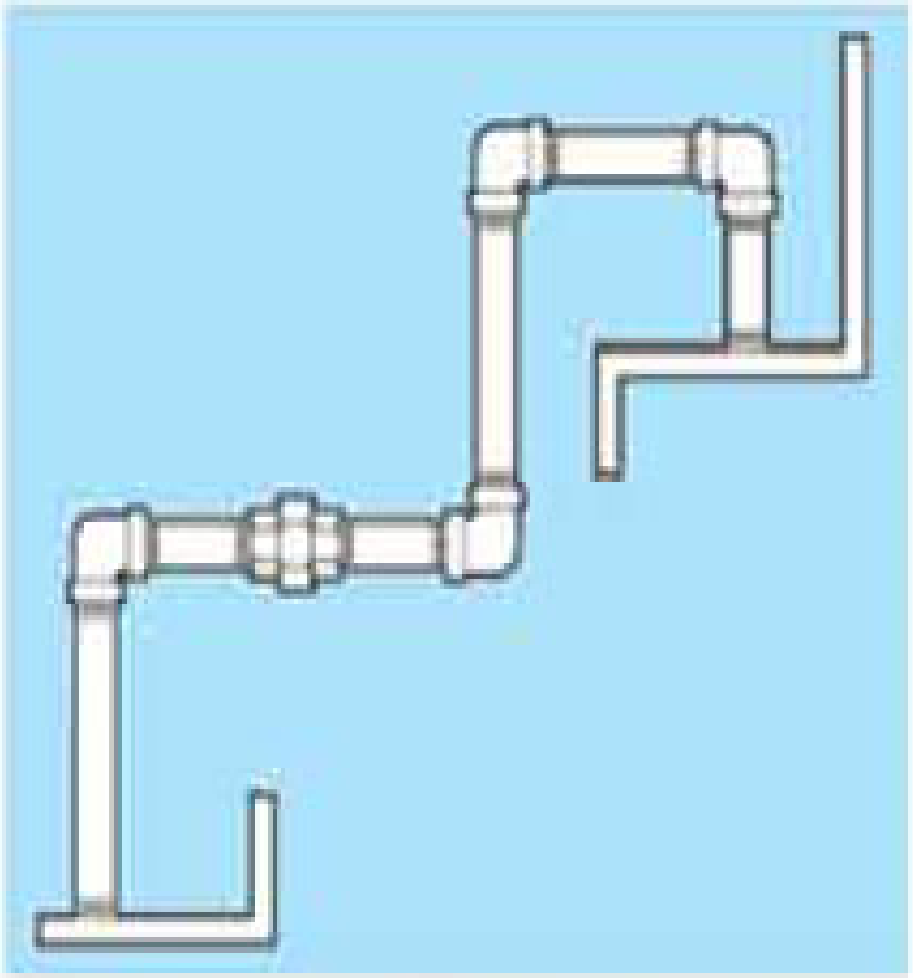




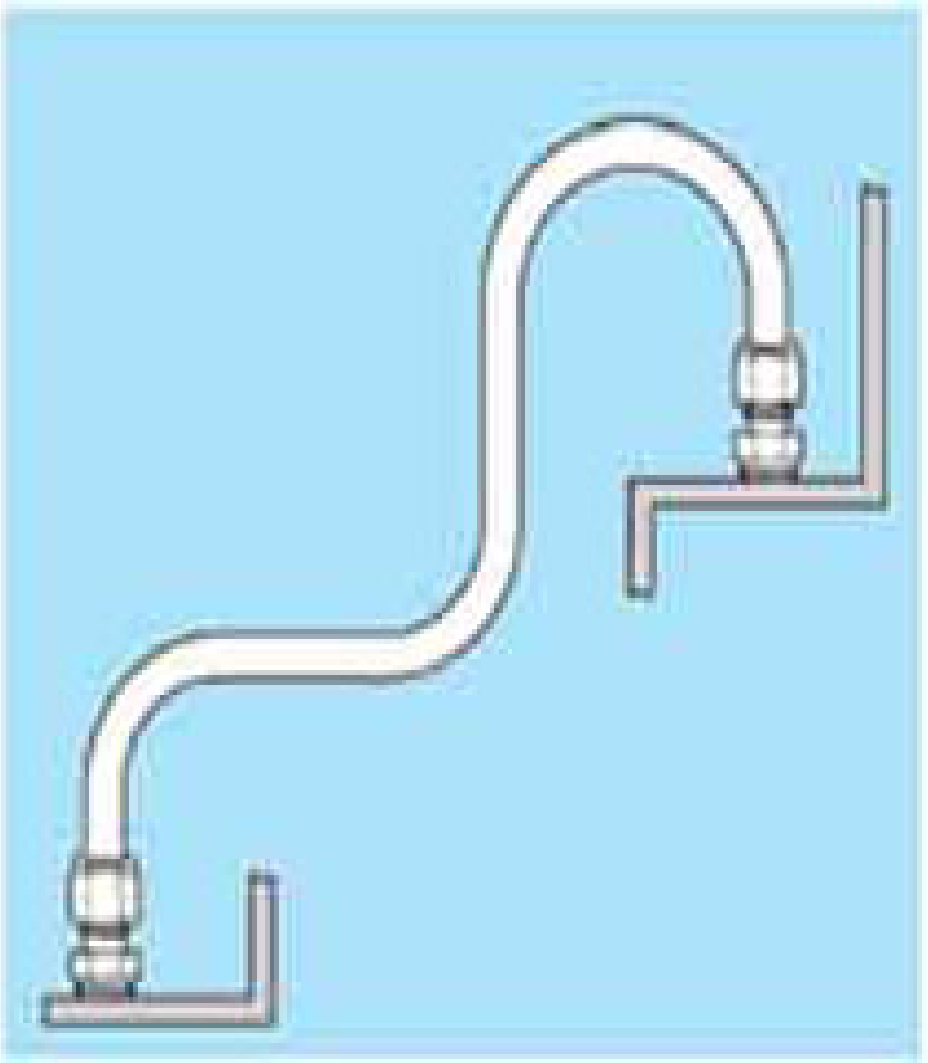
Thermal Imager is the tool to show in running process system - Do’s and Don’t’s of piping.



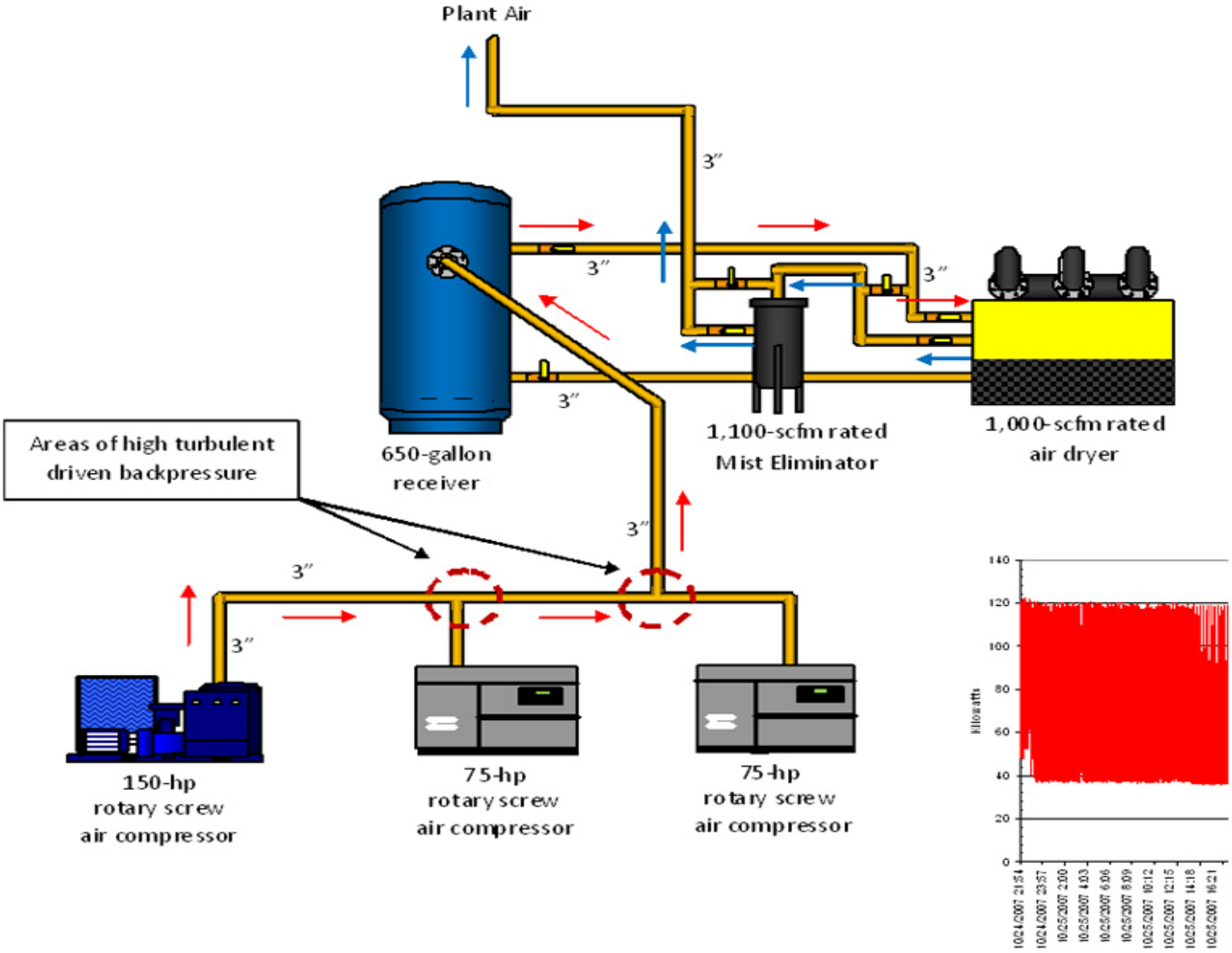
Tubing Vs Piping: Enhancing Plant Efficiency



Pipe typically relies on 45° and 90° elbows to route a system. Eliminating these fittings can speed assembly, reduce potential leak points and improve flow characteristics.



Tubing provides a more compact system and fewer leak points than an equivalent run in pipe


Plant Air
3″
3″
3″
3″
3″
650-gallon
receiver
1,100-scfm rated
Mist Eliminator
1,000-scfm rated
air dryer
Areas of high turbulent
driven backpressure
3″
3″
3″
150-hp
rotary screw
air compressor
75-hp
rotary screw
air compressor
75-hp
rotary screw
air compressor
Kilowatts
140
120
100
80
60
40
20
0
10/24/2007 21:54
10/24/2007 23:57
10/25/2007 2:00
10/25/2007 4:03
10/25/2007 6:06
10/25/2007 8:09
10/25/2007 10:12
10/25/2007 12:15
10/25/2007 14:18
10/25/2007 16:21

Compressor layout and leakages

This Is What An Ordinary Compressed Air Network Looks Like

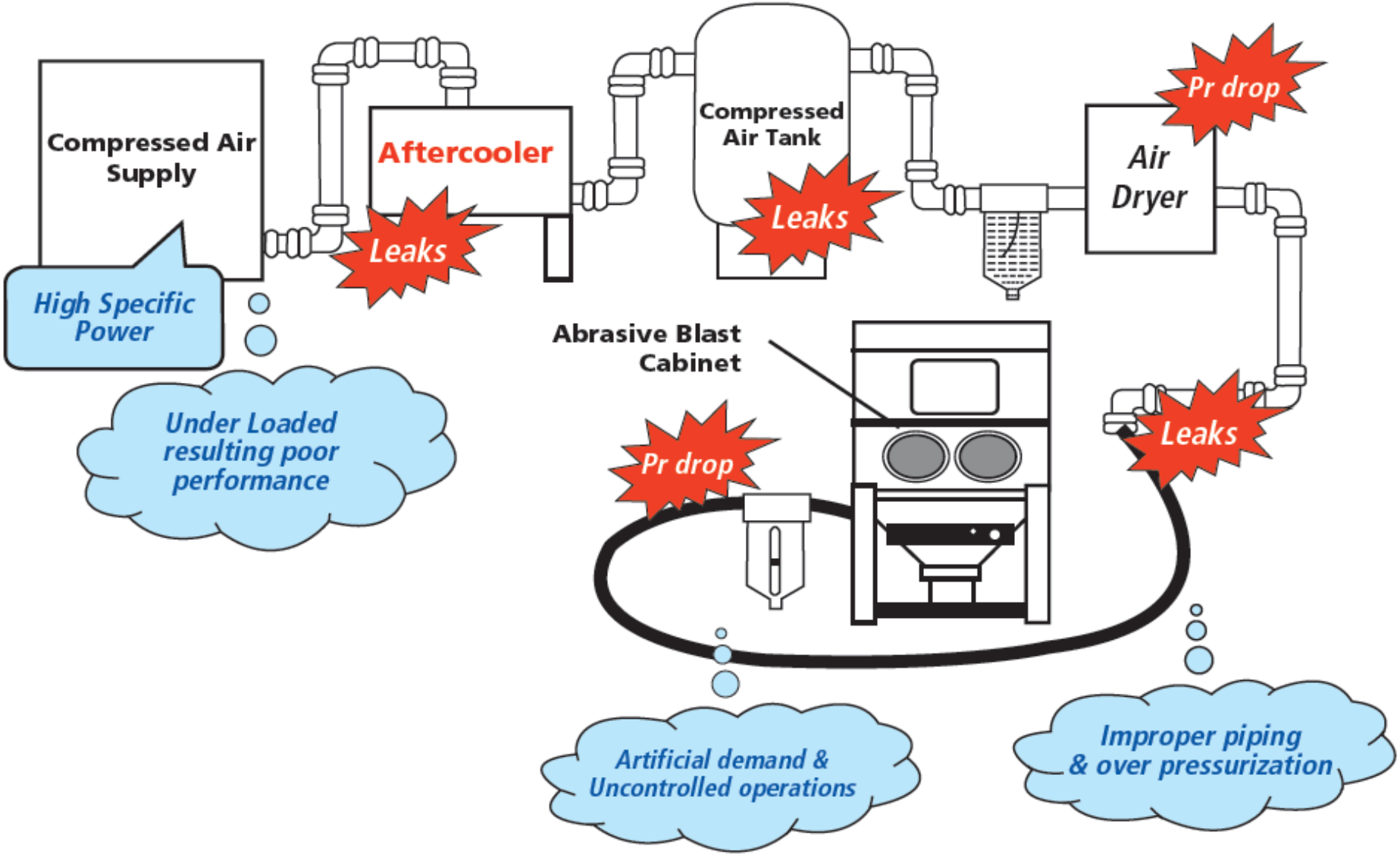
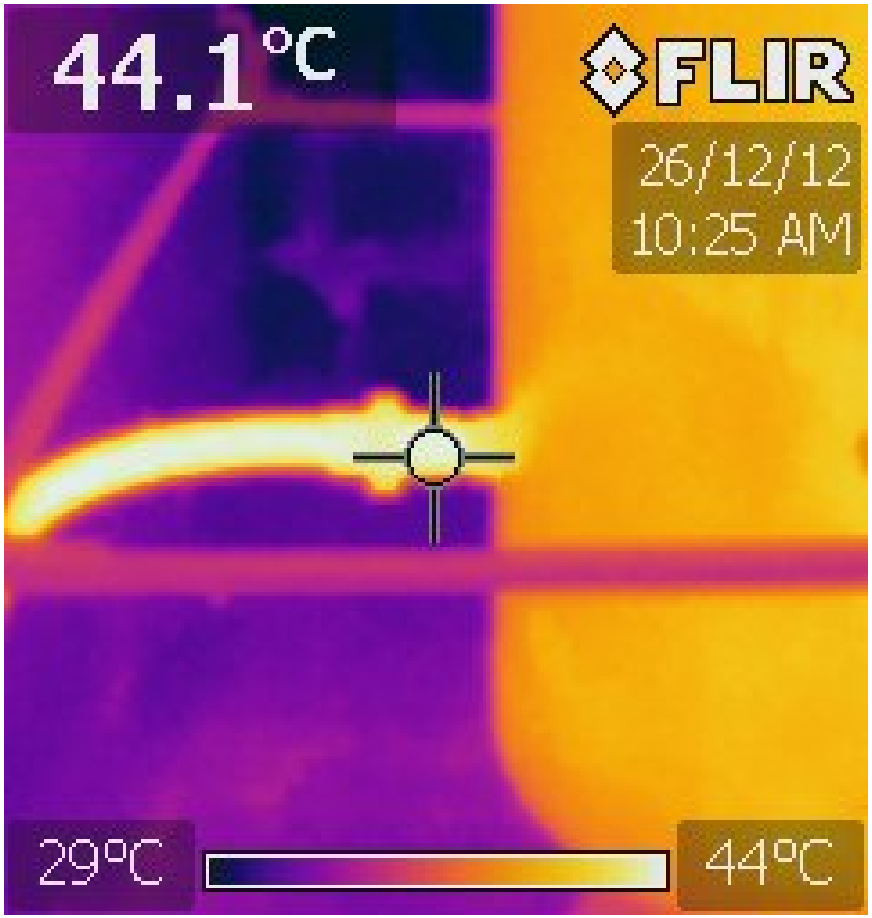
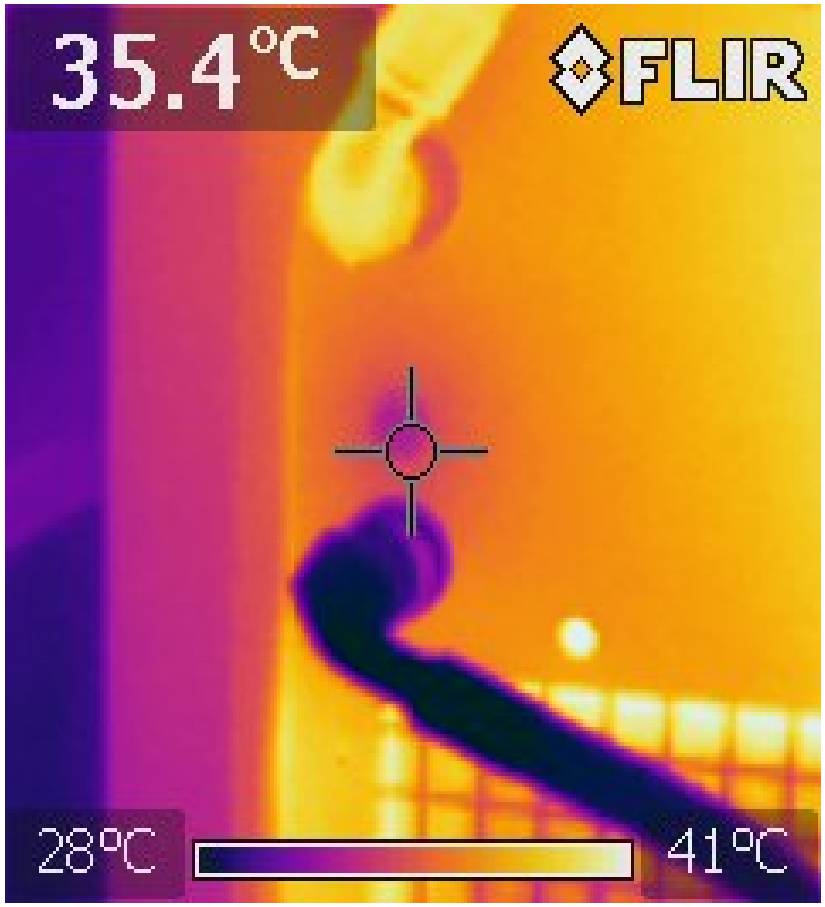


Figure 12: Typical issues of a Compressed Air System

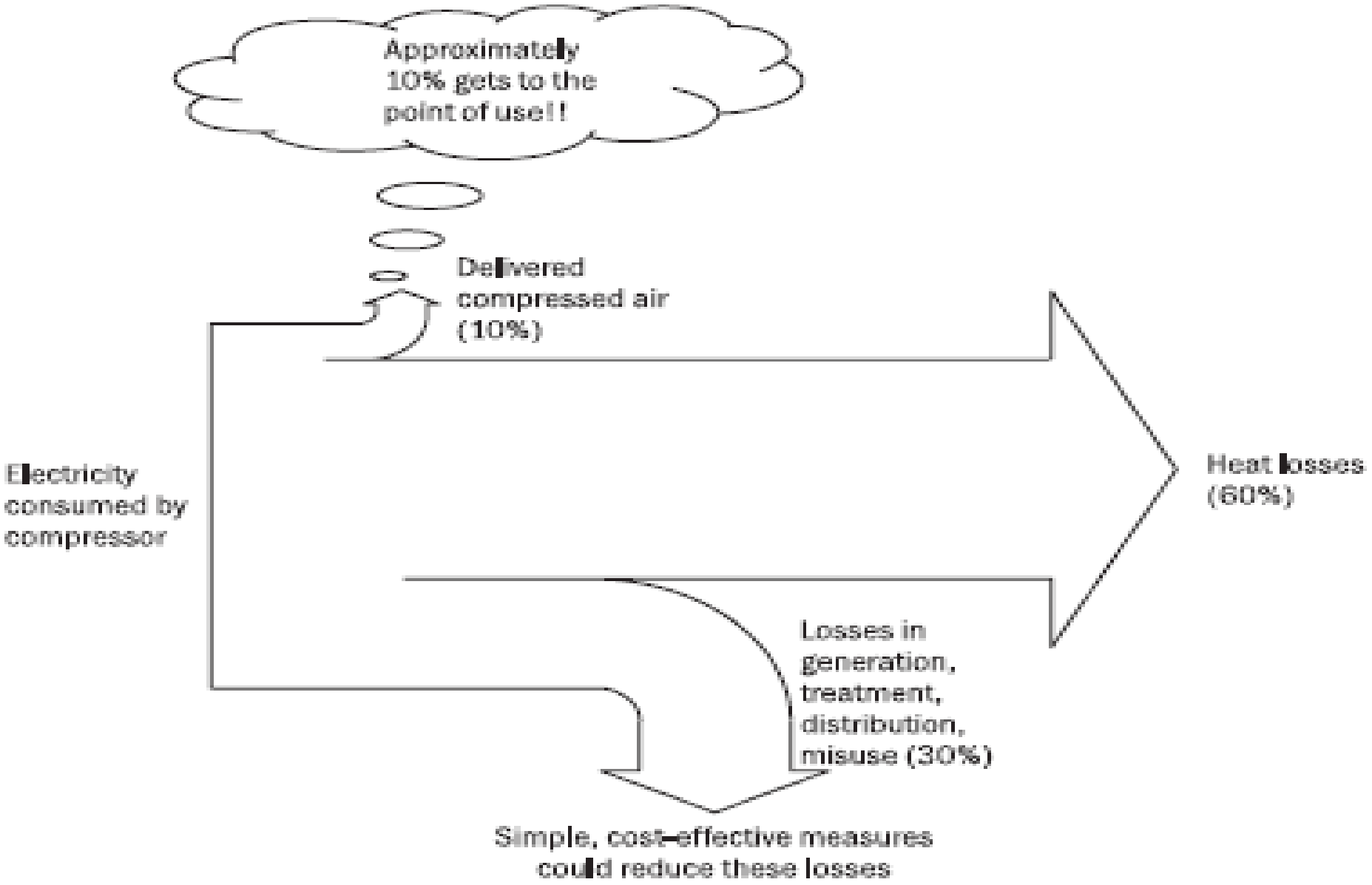
Compressed air is not healthy when discharge temp is above 5 *C than ambient.

Refrigeration dryer working is healthy when there is appreciable difference between the inlet and outlet air temperature.

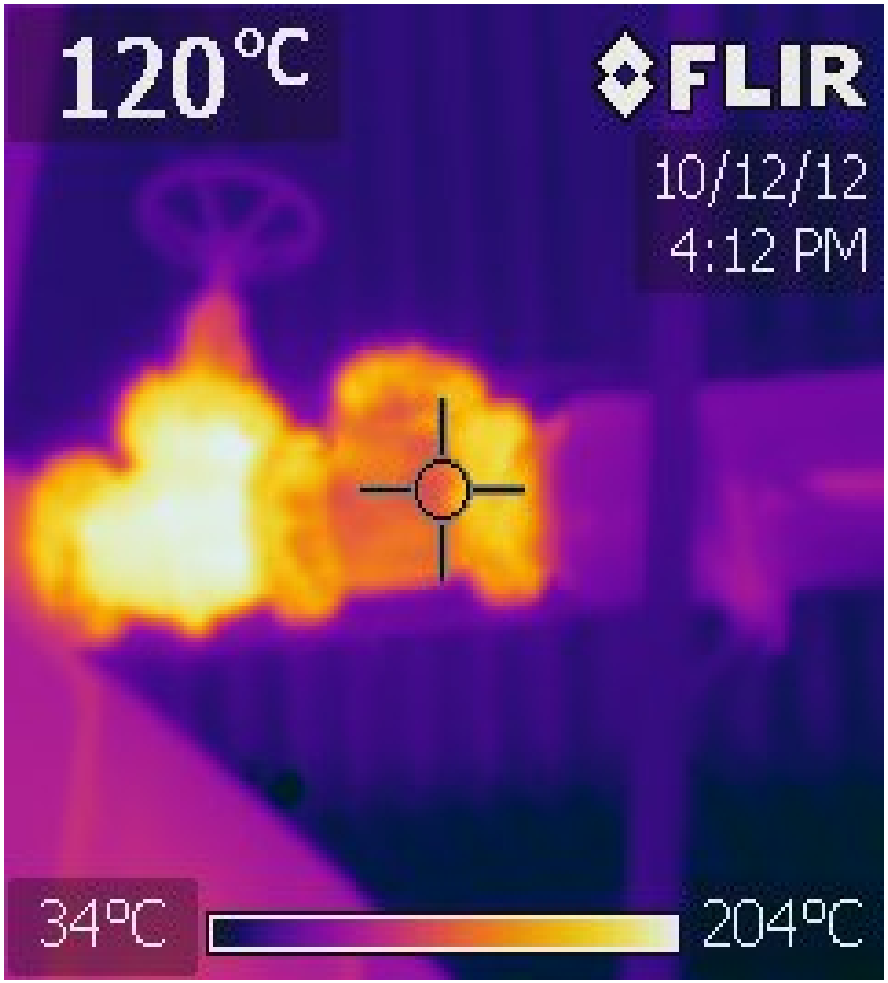


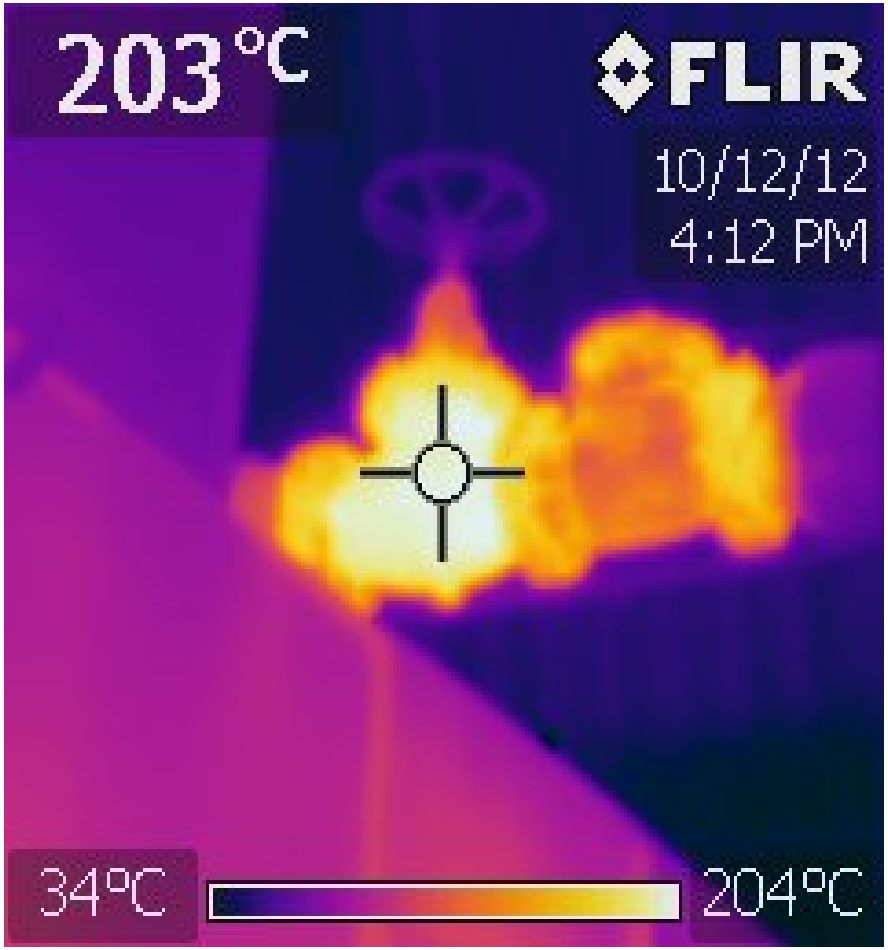


Fraction of compressed air produced only is delivered to machine. Losses in generation, distribution & usage matters.



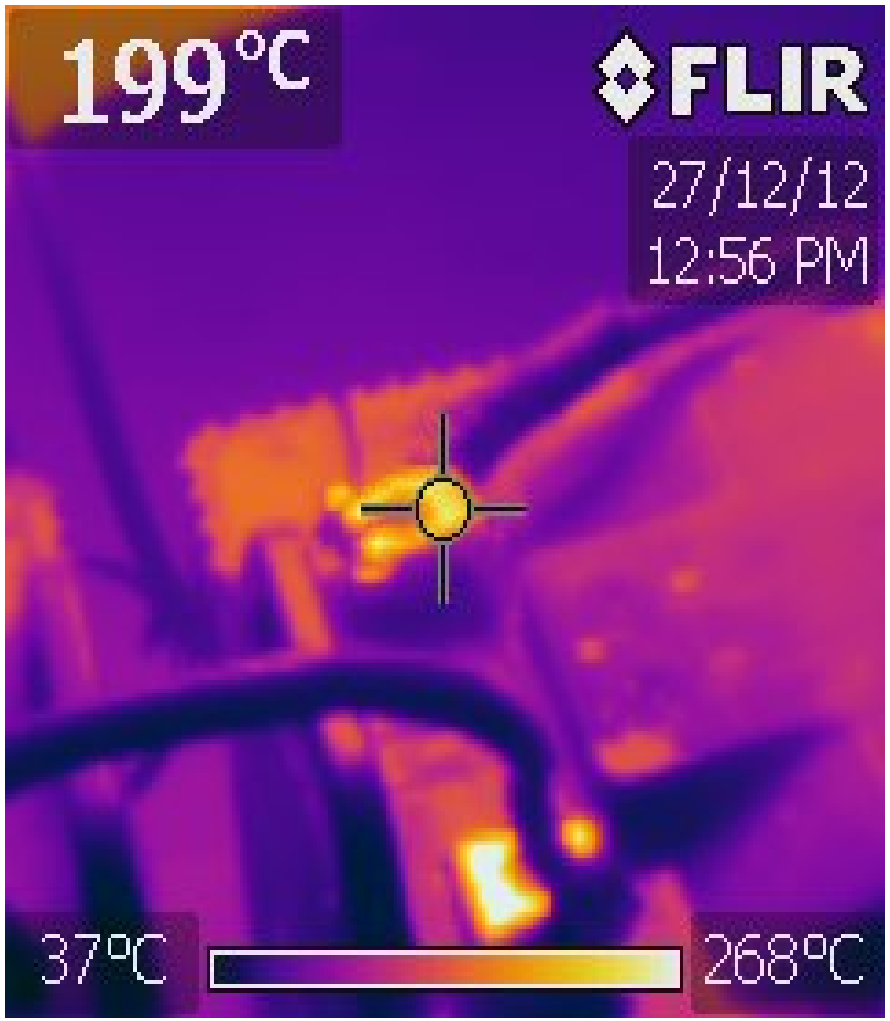
In the textile processing industry, thermic fluid main header oil flow restriction leads to productivity loss and more downtime.

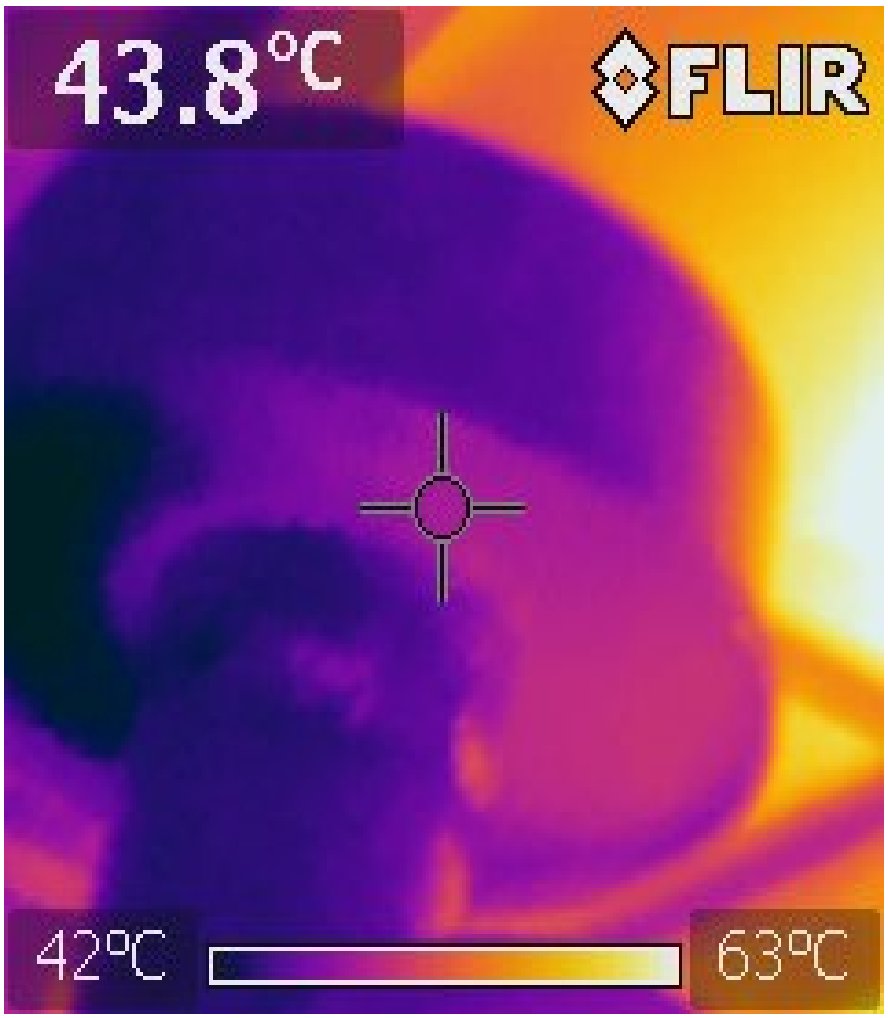




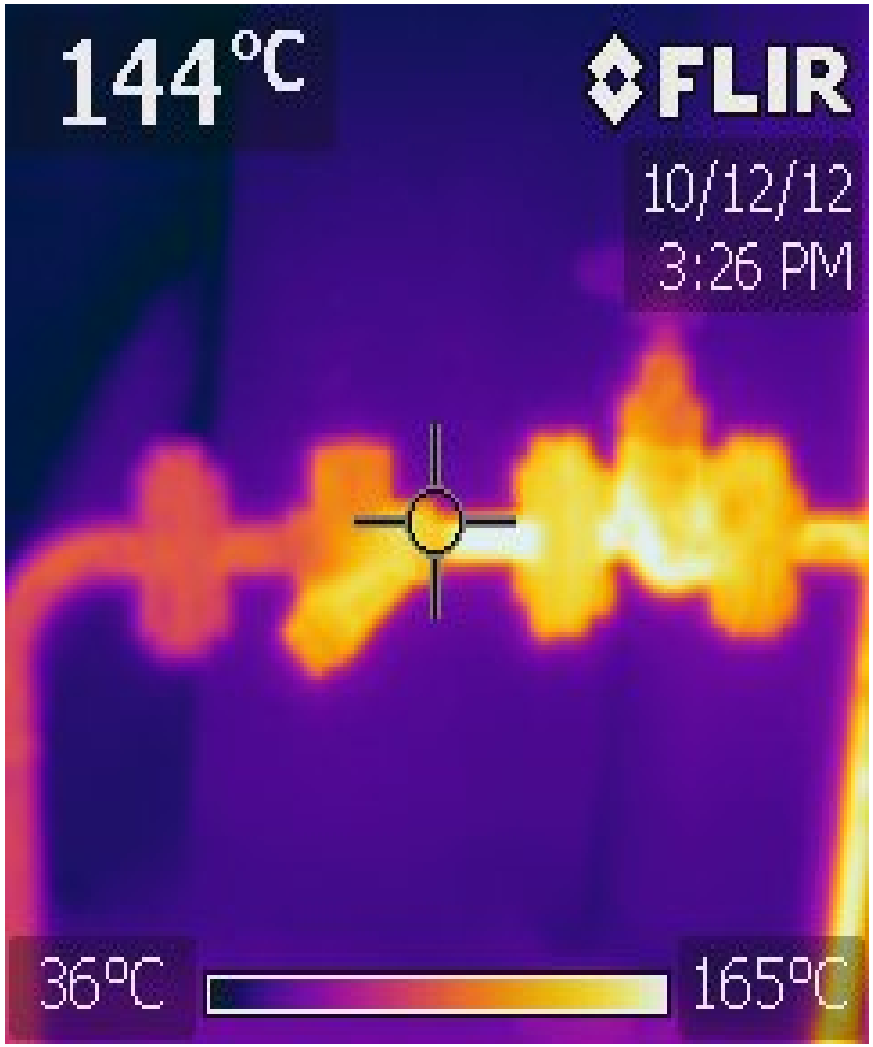
DG battery terminals loosely connected. Reason, DG consumed more Diesel, and starting problems.

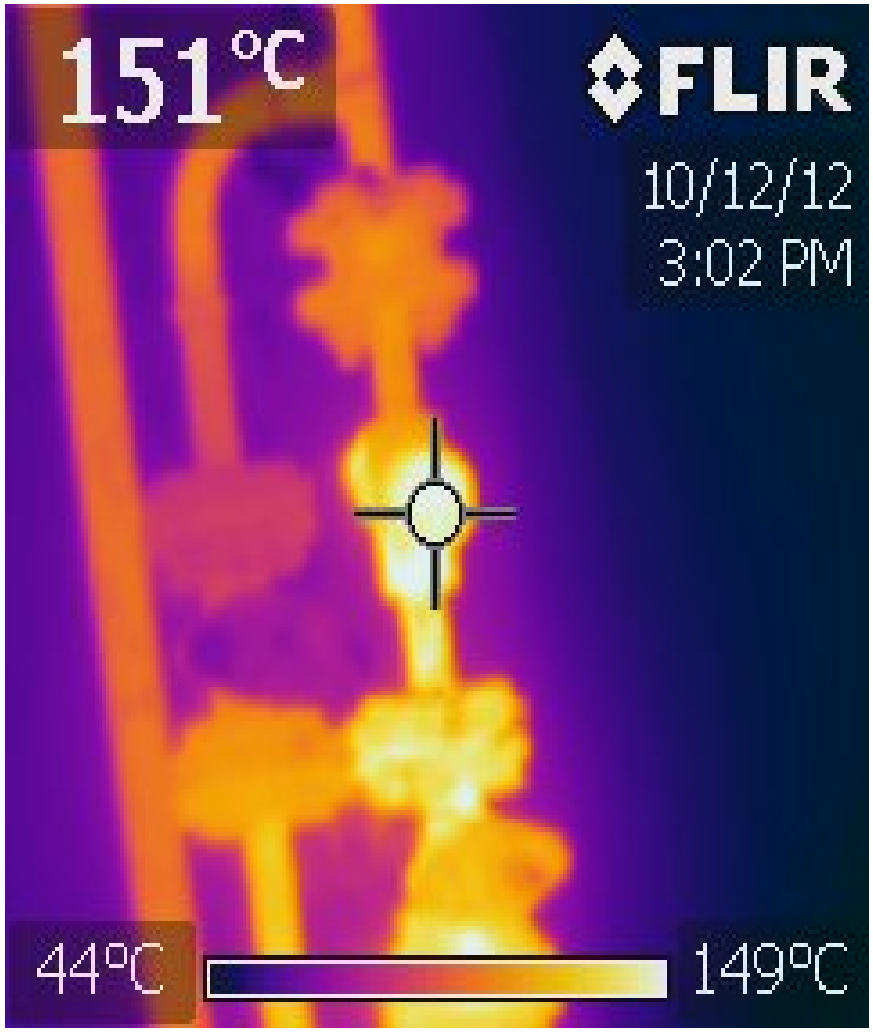
DG air intake filter relocated to give diesel savings.





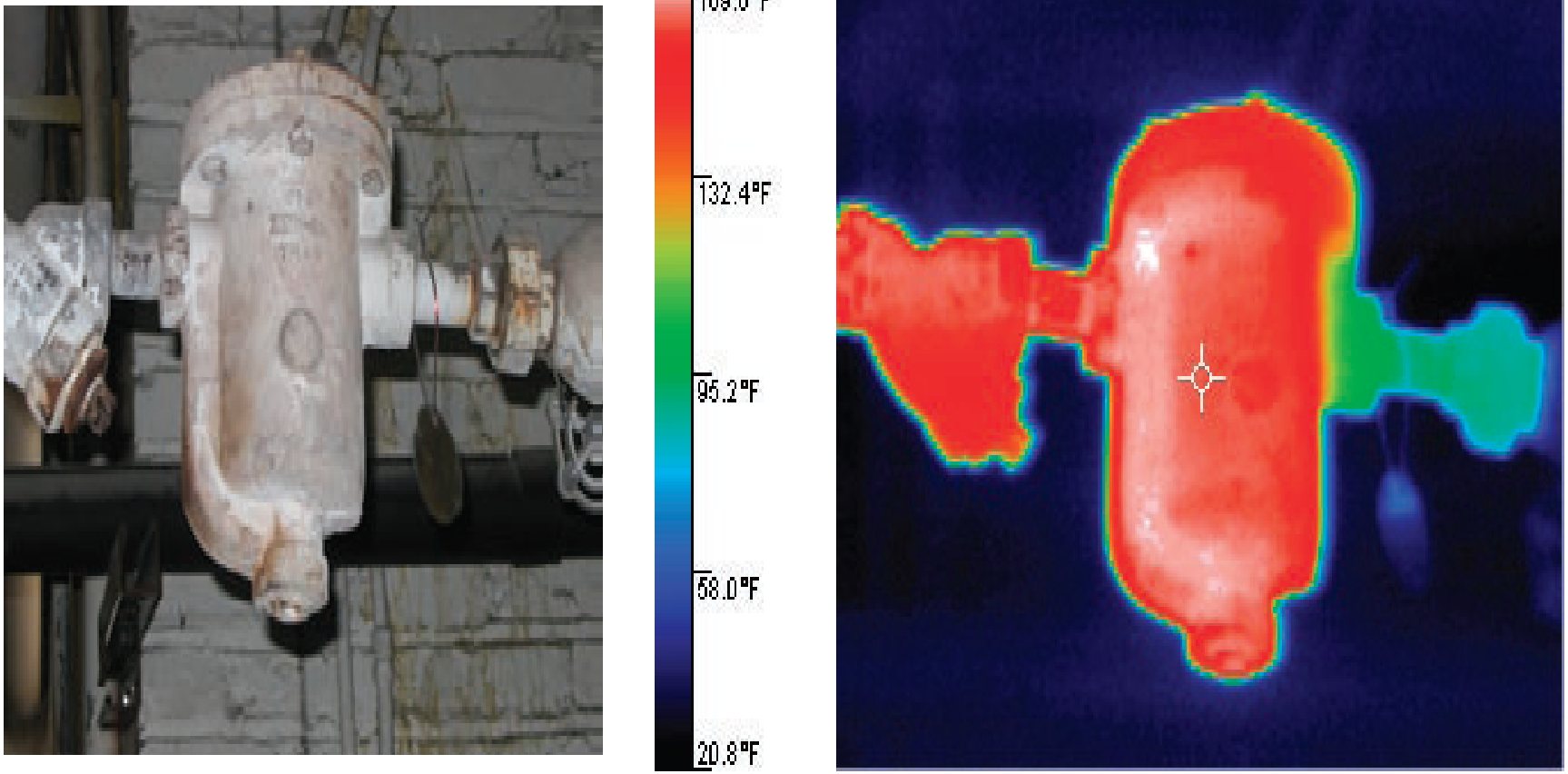
In the Steam distribution systems, every trap is a steam saver if works correctly, or loser if steam instead of water flows thro the drain.



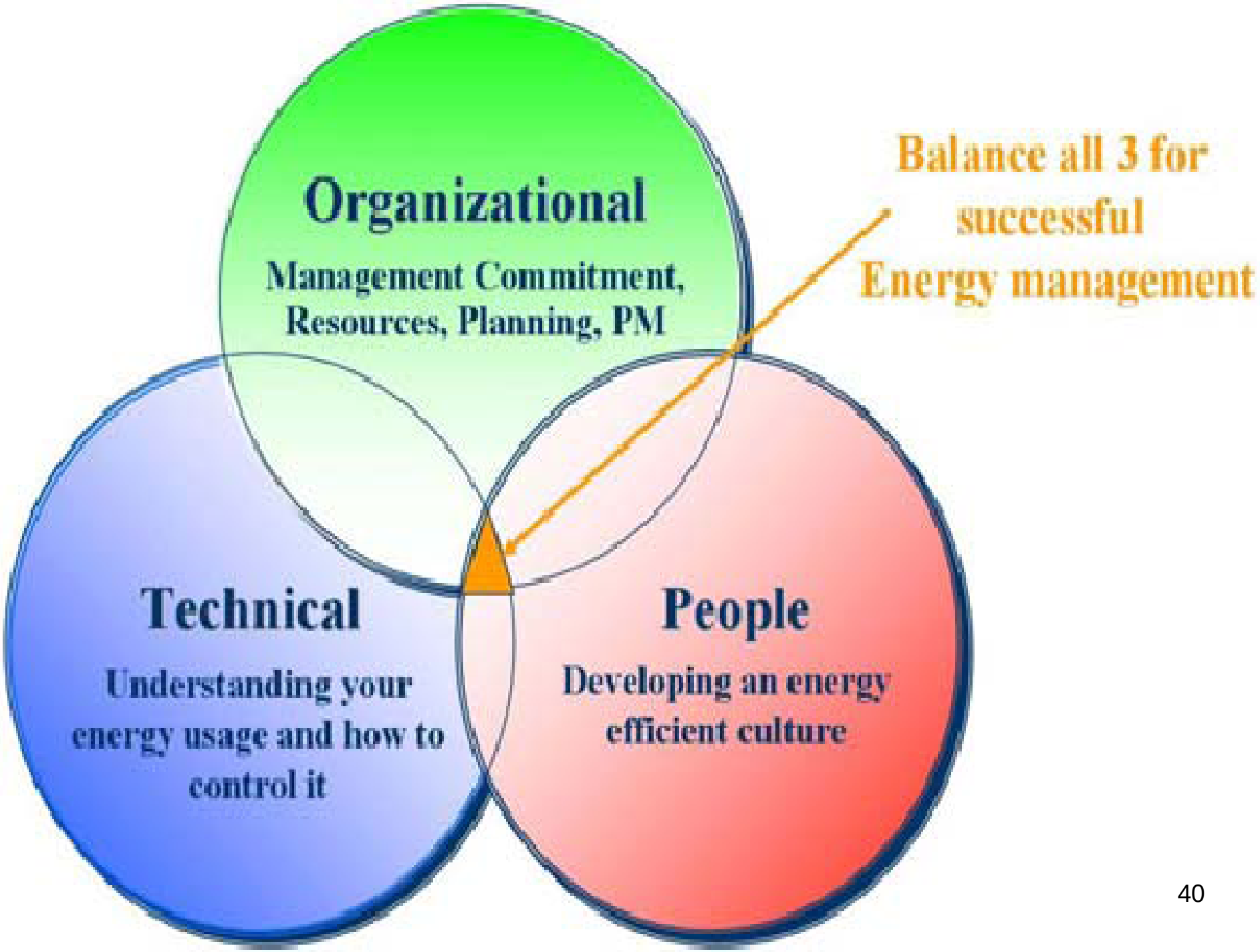


STEAM TRAP – THERMAL IMAGING

When operating correctly, as in this example, steam trap thermal images should show an abrupt change in temperature.




ecolibrium
ENERGY
20% OF INDUSTRIAL ENERGY
IS WASTED OR MISMANAGED
use our cutting edge solutions for energy monitoring, control and analytics


Organizational
Management Commitment, Resources, Planning, PM
Technical
Understanding your energy usage and how to control it
People
Developing an energy efficient culture
Balance all 3 for successful Energy management

Thank you for your kind attn Pls!

Please Feel Free to ask More Questions!!

S.ASHOK, BEE Accredited Energy Auditor /

Chairman IAEMP Coimbatore Chapter.

M/s. POWERON Projects / Coimbatore / 94437 20220

ashok@energymeasuretosave.com

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As Conservation is all about

our collective responsibility for better tomorrow