Safety Considerations for AC Motor Thermal Protection

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2016 Texas A&M Relay Conference

Induction Motors

Highly efficient machines-not perfect ones

3. STARTING PERFORMANCE - NOMINAL

		100% VOLTS	90% VOLTS
AMPS (LR)		1429	1262
AMPS (LR)	%	595	526
POWER FACTOR	%	22.2	21.8
START TORQUE	%	132	104
ACCELERATION SEC		6.9	9.0
SAFE LOCK SEC	FROM HOT	21.8	27.7
SAFE LOCK SEC	FROM COLD	25.4	32.3

PULLOUT TORQUE AT 100% VOLTS = 262 %

4. EFFICIENCY - NOMINAL

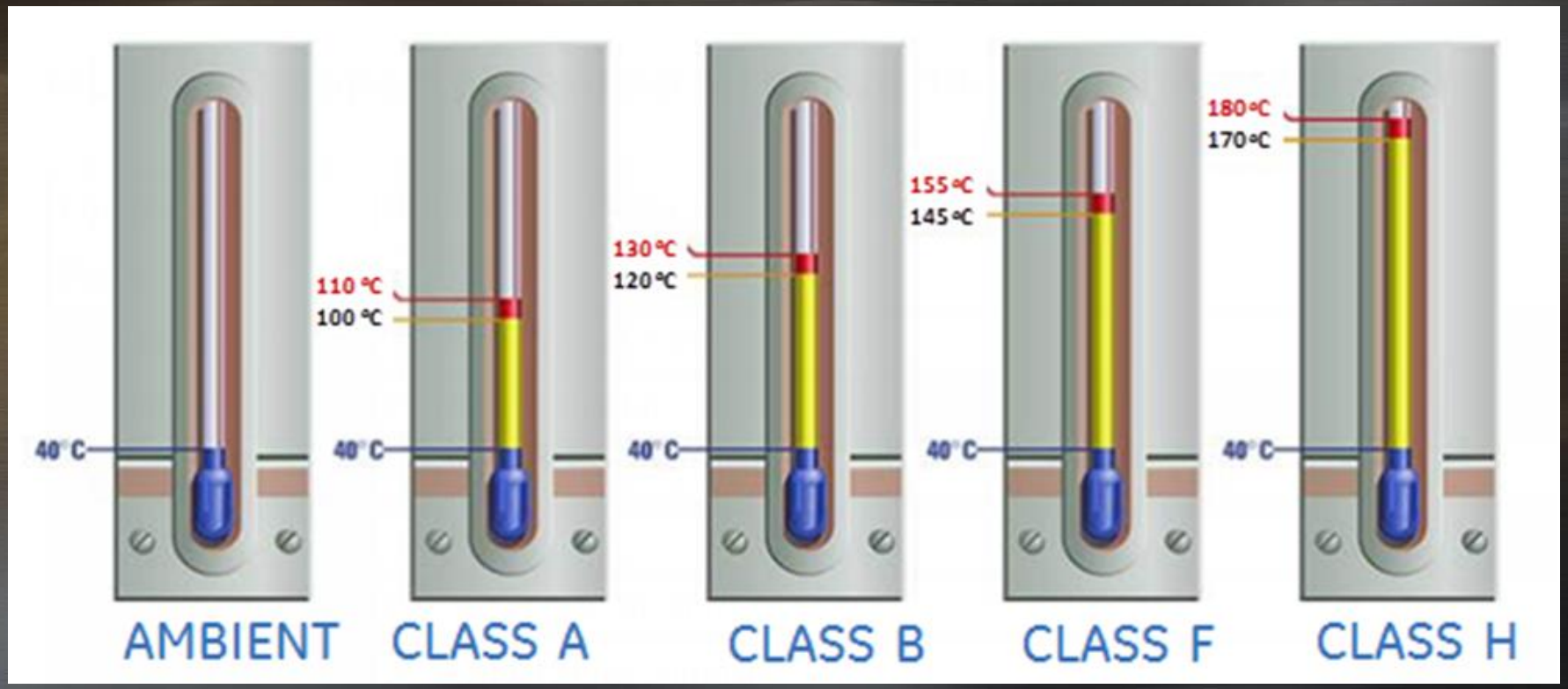
LOAD	%	115	100	75	50
EFFICIENCY	%	95.45	95.74	96.03	95.84

5. POWER FACTOR - NOMINAL

LOAD	%	115	100	75	50
POWER FACTOR	%	83.0	81.9	78.2	69.0

Induction Motors

How much heat can a motor withstand?



Hazardous Locations

National Electric Code Defines:

- Class I – Explosive Gas or Vapor
- Class II – Combustible Dust
- Class III – Combustible Fibers

- Division I – Combustibles are present, will likely be present or could be present
- Division II – Combustibles may be present but less likely than Div. I*

* All descriptions paraphrased (obviously)

Hazardous Locations

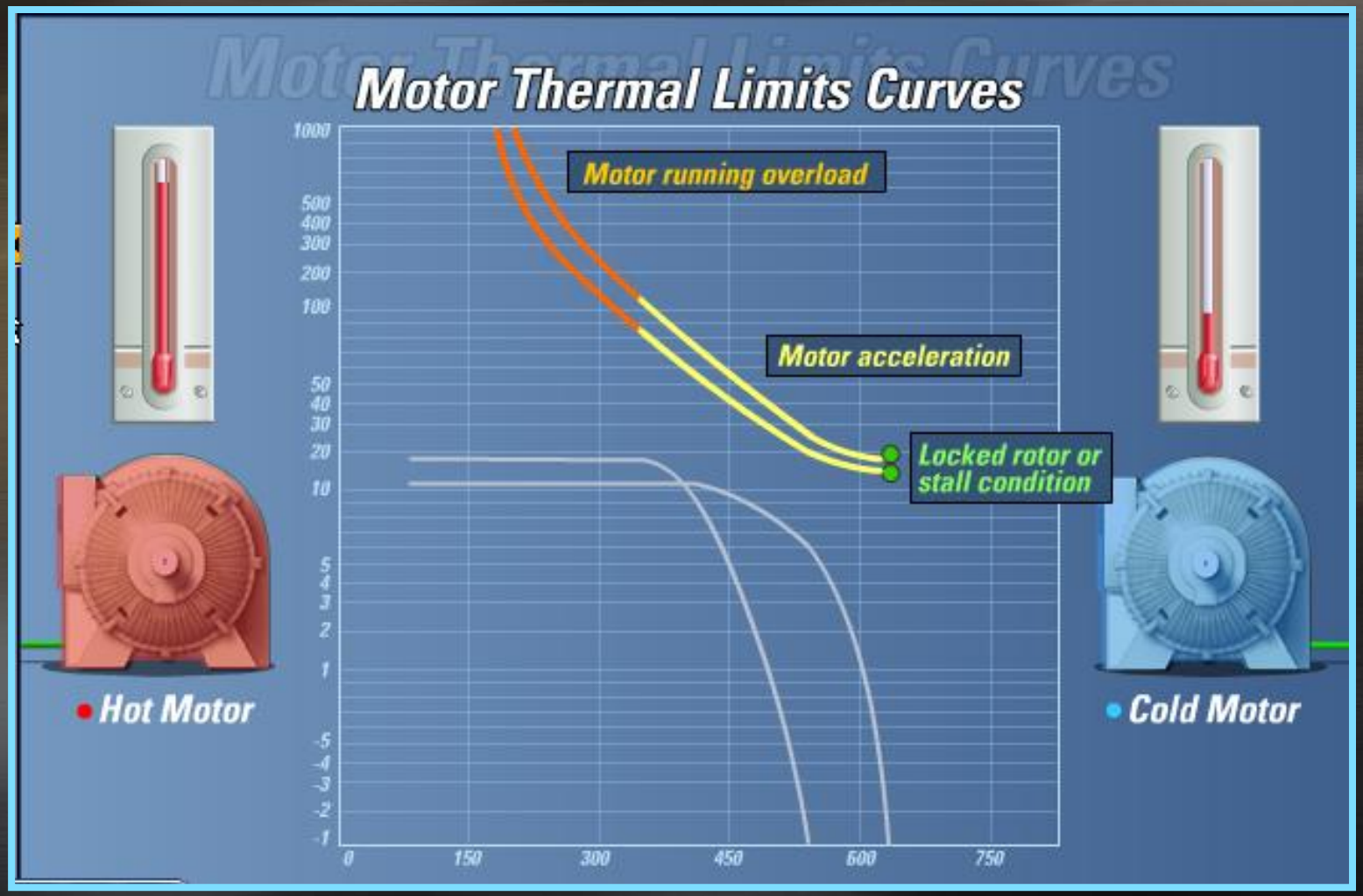
NFPA 70 – 2014 ed.

"In Class I, Division 2 locations, the installation of **open or non-explosion proof enclosed motors,** such as squirrel-cage induction motors without brushes, switching mechanisms, or similar arc-producing devices that are not identified for **use in a Class I, Division 2 location, shall be permitted."**

Informational Note No. 1: It is important to consider the temperature of internal and external surfaces that may be exposed to the flammable atmosphere.

Thermal Protection

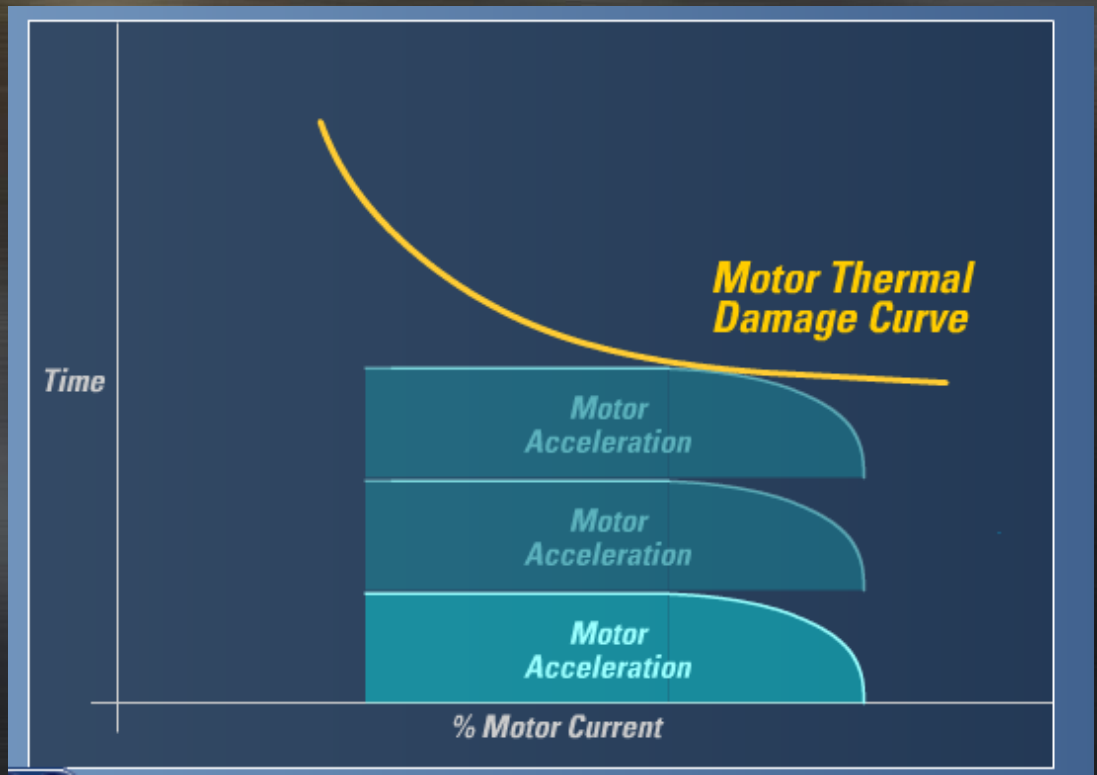
- Overload Protection – Thermal Model



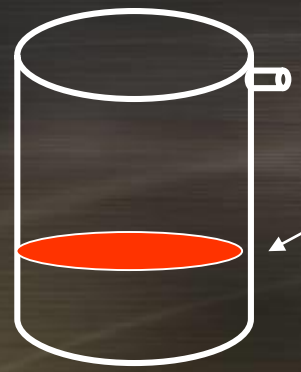
Thermal Protection

Protection Against Excessive Starts

- Starts Per Hour
- Time Between Starts
- Restart Timer
- Thermal Inhibit



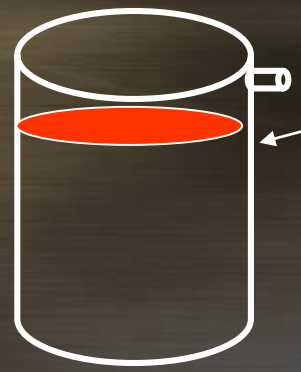
Thermal Inhibit



40%

Thermal Capacity required to start

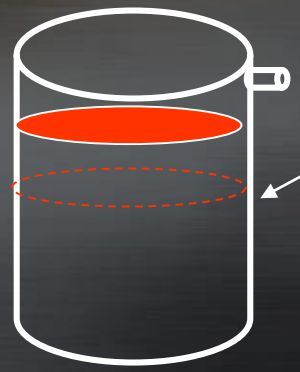
Assume that a motor requires 40% of it's thermal capacity to start.



80%

Thermal Capacity used due to Overload

If the motor had been running in an overload condition prior to stopping, the thermal capacity would be some value; say 80%.



20% { 80% / 60%

Thermal Capacity must decay by 20% (from 80% to 60% Used) in order to start the motor.

Thermal Conditions

- Thermal model is just that – a model
- Use Stator RTD's to verify that model
- Monitor Bearing RTD's to account for all major heat sources

Thermal Protection

Asset Management + Safety Concerns

Beware low autoignition temperatures!

Gas	%LEL	%UFL	AIT (°C)	Class F Thermal Limit (°C)
Acetaldehyde	4	60	175	190
Acrolein	2.8	31	235	190
Carbon Disulfide	1.3	50	90	190
Crotonaldehyde	2.1	15.5	232	190
Diethyl Ether	1.7	48	160	190
Diethylene Glycol Monobutyl Ether	0.9	24.6	204	190
Dioxane	2	22	180	190
Isobutyraldehyde	1.6	10.6	196	190
Kerosene	0.7	5.0	210	190
Monomethyl Hydrazine	2.5	92	194	190
Nonane	0.8	2.9	205	190
n-Octane	1.0	6.5	206	190
Propionaldehyde	2.6	17	207	190
Propyl Ether	1.3	7.0	215	190
Propyl Nitrate	2.0	100	175	190

Secure the System

Physical Security

Secure the System

Password Security – Role Based

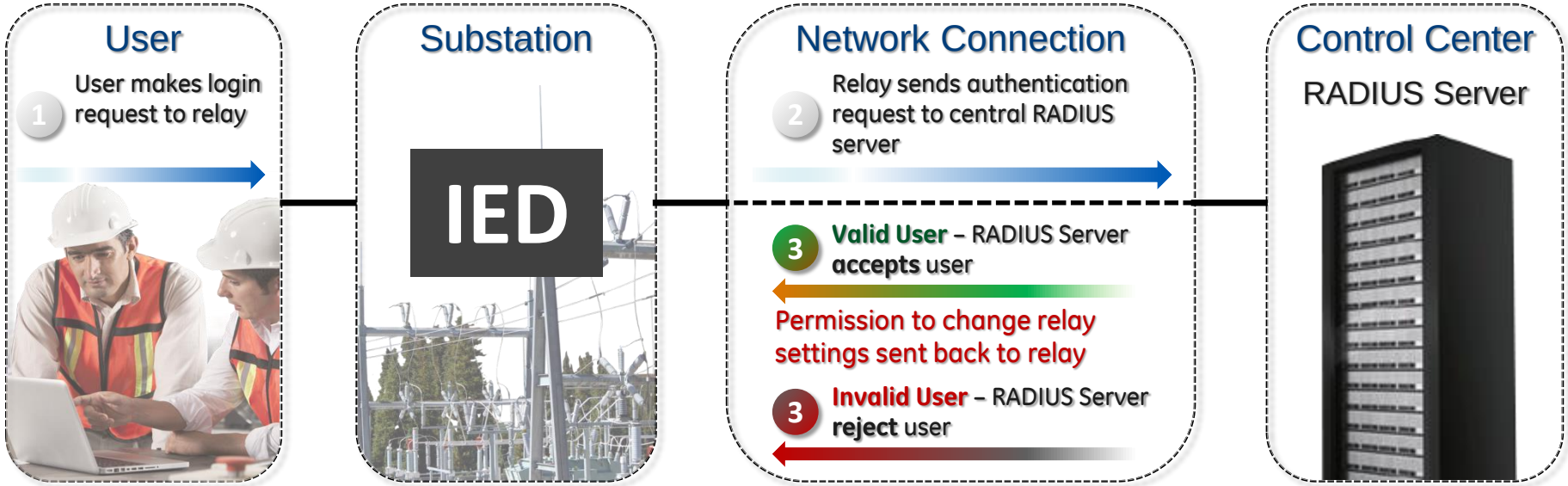
Role-Based Access Control (RBAC) system provides selective access to relay operations and configurations - based on specific roles and individual user accounts

Roles:

- Administrator – Enter settings
- Operator – Open/Close breakers
- Observer - Collects data

Secure the System

Password Security – Centrally Managed



Monitor the System

[redacted] - Compliance Report

Syslog

Filter	Selection
Report	Incident Cases
Category	All
Status	Closed
SDs / Devices	All
Time Span	2012-04-13 13:25:48 to 2012-04-13 23:59:59

Generation	Details
By	Brown, James
Date	2012-04-13 15:19:56

Report Summary

SD	Owner	Total SE	Open SE	Closed SE	Total IC	Open IC	Closed IC
New_SD_2	Brown, James	0	0	0	1	0	1

SD:New_SD_2

Device	Description	Total SE	Open SE	Closed SE	Total IC	Open IC	Closed IC
Judd_UR		0	0	0	1	0	1

CS12-000001 Incident Case / Closed Device: Judd_UR

Date	Category	Assignee	Description	Deadline Date
2012-04-13 15:10:17	Loss of Communication	Brown, James	Comms failed for Judd_UR	2012-05-13

History	Action	Comment
2012-04-13 14:28:25	Assigned (James Brown), Assignee (Joe Smith)	Joe, can you please see why this device is not communicating. Thanks James
2012-04-13 15:01:03	Attachment (Joe Smith)	James, squirrels chewed through the communication cable. I've attached the picture
2012-04-13 15:10:16	Promoted (Joe Smith), Assignee (James Brown)	James, I raised the IC.
2012-04-13 15:11:35	Assigned (James Brown), Assignee (Joe Smith)	Joe, please repair the communication cable ASAP. Thanks James
2012-04-13 15:13:13	Attachment (Joe Smith)	James, repairs are made and I've rerouted the wiring. I've attached the picture.
2012-04-13 15:15:51	Reviewed (Joe Smith)	The work is completed.
2012-04-13 15:17:26	Closed (James Brown)	Examined photos to approve installation. Device successfully communicating

Conclusions

- Motor protection isn't just to protect the motor
- Open motors can/may be installed in Class I Div II locations
- "Emergency Restart" should be seldom used and with careful consideration
- Modern relays can be applied to protect the motor, manage access, and monitor/alarm.

Thank You

Questions?