1.0 Introduction and Terminology

1.1 Purpose

Section 1 provides introductory information to help the reader of this EDOC better understand the meaning and purpose of Lifting Motor Duty Ratings and Hoist Classifications. Also, some terminology and organization names are defined.

1.2 Background

Harrington offers many different hoist types to many different end users. All hoists have certain capabilities and certain limitations while all end users have different requirements and applications in mind. Because of the variety of product and end user, it is necessary to have systems in place to make sure each hoist is suitable for the application for which it is intended.

1.3 Scope

Hoist Classifications and Duty Ratings apply to any hoist. Lifting Motor Ratings apply to the motor within an electric hoist.

1.4 Glossary of Terms *(alphabetically)*

ASME- *(American Society of Mechanical Engineers)*- A professional engineering society founded in 1880 that is widely known for establishing codes and standards for mechanical devices.

Cubic Mean Value (k)- Percentage of W.L.L. (working load limit). Ex: k=0.63 means 63% of W.L.L.

Duty Rating- The classification given to a hoist indicating the amount of use and type of use it can withstand during a given time period.

FEM- (*European Federation of Materials Handling)*- An association founded in 1953 that represents manufacturers of materials handling, lifting and storage equipment. FEM is involved with establishing technical recommendations and guidelines.

Hoist Classification- The categorization of hoists is according to state of loading, duration of use and area of application.

ISO- (*International Organization for Standardization)*- An international organization founded in 1947 that issues worldwide industrial and commercial standards.

JIS- (*Japanese Industrial Standards)*- Standards used for industrial activities in Japan published through JSA- *Japanese Standards Association*.

Lifting Motor- Rotating machine that transforms electrical energy into mechanical energy.

Lifting Motor Rating- A rating of an electric motor's capability indicated by how long a certain cycle of use can be maintained, a ratio of motor on-to-off time (% ED) and a maximum number of starts per hour.

Mean Effective Load- A theoretical single load value that will have the same effect on the hoist mechanism as various, randomly distributed loads that are applied to the hoist in some specified period of time.

Mean Effective Load Factor (K)- A ratio of the Mean Effective Load to the hoist rated capacity.

State of Loading- An indication of the frequency and magnitude of loads a hoist can handle.

W.L.L.- *(Working Load Limit)*- The maximum load which should be applied to the hoist.

2.0 Lifting Motor Duty Ratings

2.1 Purpose

Section 2 discusses Lifting Motor Duty Ratings. Section 2.2 discusses Short Time Rating and section 2.3 discusses Intermittent Rating (% ED) / Maximum Number of Starts per Hour.

2.2 Short Time Rating

Short Time Rating is a rating of how many minutes a hoist can be operated continuously at the W.L.L. This rating relates to the rise in motor temperature that occurs during operation.

In order to be given a Short Time Rating of 60 min., a hoist must endure 60 min. of the cycle depicted in Figure 1 at its W.L.L. without exceeding its allowable maximum temperature and without showing signs of damage. This cycle consists of a lift of 1 meter, a 3 second stop, a lowering of 1 meter and another 3 second stop before the cycle is repeated.

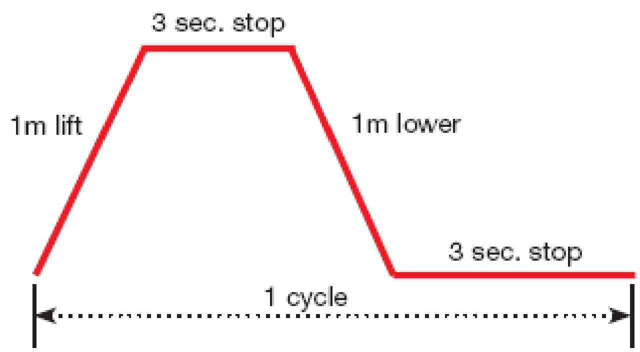

Figure 1. Short Time Rating Cycle

Any *Single Speed* ER Series Harrington Hoist, single phase or 3-phase, could endure this cycle for 60 consecutive minutes, earning its 60 min. Short Time Lifting Motor Rating.

A *Dual Speed* ER Harrington Hoist could endure this cycle for 30 consecutive minutes on its high speed and for 10 consecutive minutes on its low speed, earning it its 30/10 min. Short Time Lifting Motor Rating. The higher of the two speeds can endure longer operation because when the motor speed is higher, the cooling fan speed will also be higher. Therefore, the hoist cools itself more effectively at a higher speed.

2.3 Intermittent Duty Rating (% ED) / Max. Number of Starts

Intermittent Duty Rating (% ED) indicates how much time a hoist can be operating within a given period of time - (a maximum of 10 minutes). This rating also relates to the rise in motor temperature that occurs during operation. The cycle in Figure 2 is specified for a hoist being operated at 63% of the W.L.L.

For a Single Speed Hoist

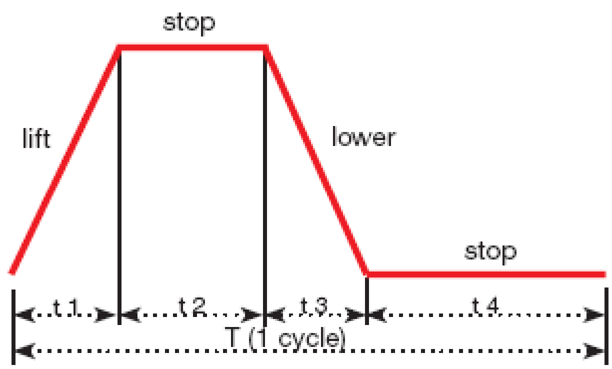

Figure 2. Intermittent Rating (% ED) Cycle For A Single Speed Hoist

The cycle consists of a lift of duration t1, a stop of duration t2, a lowering period of duration t3 and another stop of duration t4 before the cycle is repeated. T represents the total time to complete the cycle where the total time is no greater than 10 minutes.

% ED Is Calculated By:

- % ED =[(t1 + t3) / T] x100
  =[(motor ON time) / (total cycle time)] x100

% ED and Max Starts Per Hour:

FEM 9.682 designates the maximum starts for 60%ED to be 360 starts per hour. If the allowable number of starts per hour is exceeded, a hoist could be operated within 60%ED and still experience excessive temperature rise. This could occur because when a motor starts from a complete stop, it experiences a “spike” in current that exceeds the rated motor current. This current spike generates extra heat and could cause defects or motor burning if 360 starts per hour is exceeded.

What This Means:

If a single hoist is operated under the limitations of its designated rating and starts per hour, the rise in motor temperature will not exceed the maximum allowable motor temperature. If the hoist is operated in this manner, the hoist can be operated continuously in consecutive hours.

For a Dual Speed Hoist

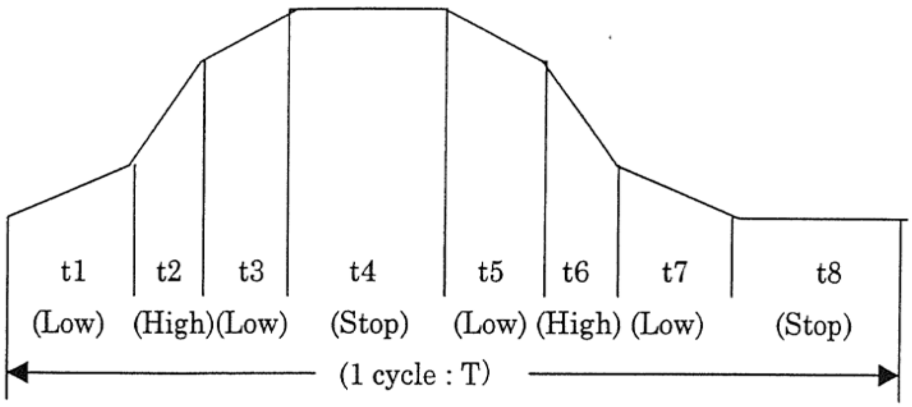

Figure 3. Intermittent Rating (% ED) Cycle For A Dual Speed Hoist

This cycle consists of a low speed lift (t1), a high speed lift (t2), a low speed lift (t3), a stop (t4), a low speed lowering (t5), a high speed lowering (t6), a low speed lowering (t7) and a stop (t8). T represents the total time to complete the cycle where the total time is *no greater than 10 minutes*.

% ED Is Calculated By:

- % ED (Low Speed) = [(t1 + t3 + t5 + t7) / T] x100
  = [(motor ON time at low speed) / (total cycle time)] x100
- % ED (High Speed) = [(t2 + t6) / T] x100
  = [(motor ON time at high speed) / (total cycle time)] x100
- % ED (Total = Low Speed + High Speed)
  =[(t1 + t2 + t3 + t5 + t6 + t7) / T] x100
  =[(motor ON time total) / (total cycle time)] x100

As the third formula above shows, total %ED for a dual speed hoist is the sum of the Low speed and High speed %ED.

In the case of a Dual speed ER hoist, the %ED is 40(High speed)/20(Low speed). Therefore, its total %ED would be (40%ED + 20%ED) = 60%ED.

% ED and Max Starts Per Hour:

As mentioned earlier, FEM 9.682 designates the maximum starts for 60%ED to be 360 starts per hour. As seen in Figure 3, the cycle alternates between low and high speed, beginning and ending with low speed. Therefore, the cycle consists of 4 low speed motor starts and 2 high speed motor starts, making the ratio of low speed to high speed starts 2:1. In accordance with this ratio, the allowable starts per hour is divided into 240 allowed at low speed and 120 allowed at high speed, maintaining a total of 360 starts per hour.

What This Means:

If a dual hoist is operated under the limitations of its designated rating and starts per hour, the rise in temperature will not exceed the maximum allowable motor temperature. If the hoist is operated in this manner, the hoist can be operated continuously in consecutive hours.

3.0 Hoist Classifications

3.1 Purpose

Section 3 discusses Hoist Classifications. Section 3.2 discusses ASME HST classification, section 3.3 discusses ISO/JIS classification and section 3.4 discusses the relation between FEM and ISO classifications.

3.2 ASME HST

Figure 4 shows the various hoist duty classifications as determined by ASME HST.

Hoist Duty Class	Typical Areas of Application	Operation Time Ratings at K = 0.65*			
		Uniformly Distributed Work Periods		Infrequent Work Periods	
		Max. Time (min/hr)	Max. No. of Starts/hr	Max. Time From Cold Start (min)	Max. No. of starts
H2	Light machine shop fabricating, service and maintenance; loads and utilization randomly distributed; rated loads infrequently handled	7.5 (12.5%)	75	15	100
H3	General machine shop fabricating, assembly, storage, and warehousing; loads and utilization randomly distributed	15 (25%)	150	30	200
H4	High volume handling in steel warehouses, machine shops, fabricating plants and mills, and foundries; manual or automatic cycling operations in heat treating and plating; loads at or near rated load frequently handled	30 (50%)	300	30	300

*K = Mean effective load factor.

Figure 4. Hoist Classifications determined by ASME HST.

As Indicated by Figure 4:

Three Hoist Duty Classes (H2, H3, and H4) are indicated next to their corresponding typical area of application. Each typical area of application is designated according to volume of handling and how frequently the rated load would be lifted. The information shown on the right of Figure 4 is listed assuming operation at K=0.65 (65% of W.L.L.).

The information shown on the right of Figure 3 is divided into 2 sub-categories:

- *Uniformly Distributed Work Periods*- work periods that are evenly spaced and predictable over an hour long period.
- *Infrequent Work Periods*- work periods that occur at irregular intervals.

Example: A hoist required to handle a high volume of lifts that are frequently at or near the rated load should have an H4 rating.

3.3 ISO / JIS Classification

Figure 5 shows the various hoist classifications as determined by ISO / JIS.

State of loading		Total duration of use (h)						
		200	400	800	1600	3200	6300	12500
Light	Mechanisms subjected very rarely to the maximum load and, normally, to light loads	–	–	M1	M2	M3	M4	M5
Moderate	Mechanisms subjected fairly frequently to the maximum load but, normally, to rather moderate loads	–	M1	M2	M3	M4	M5	M6
Heavy	Mechanisms subjected frequently to the maximum load and, normally, to loads of heavy magnitude	M1	M2	M3	M4	M5	M6	–
Very Heavy	Mechanisms subjected regularly to the maximum load	M2	M3	M4	M5	M6	–	–

This classification refers to ISO 4301-1 and applies to the mechanical components including gears and bearings except for consumable parts.

Figure 5. ISO / JIS Hoist Classifications

As Indicated by Figure 5:

State of Loading and Total Duration of Use are the factors used to determine the hoist classification that should be used: M1, M2, M3, M4, M5, or M6. Cross referencing the two factors with one another will lead to a classification choice in the chart.

- Example: A hoist that would be subjected frequently to the maximum load and, normally, to loads of heavy magnitude (a “heavy” state of loading), that requires a life span of 1600 hours should be in classification group M5.

- Example 2: A hoist that would be subjected very rarely to the maximum load and, normally, to light loads (a “light” state of loading), that requires a life span of 6300 hours should be in classification group M4.

3.4 FEM and ISO Classification

Figure 6 shows the relation between ISO and FEM classifications.

1 Dm	1 Cm	1 Bm	1 Am	2 m	3 m	4 m	5 m
M 1	M 2	M 3	M 4	M 5	M 6	M 7	M 8

Load spectrum	Cubic mean value	Class of operation time								
		V 0.06	V 0.02	V 0.25	V 0.5	V 1	V 2	V 3	V 4	V 5
		T 0	T 1	T 2	T 3	T 4	T 5	T 6	T 7	T 8
		Average operating time per day in hours								
		≤0.12	≤0.25	≤0.5	≤1	≤2	≤4	≤8	≤16	>16
1 L1	K≤0.50	–	–	1 Dm	1 Cm	1 Bm	1 Am	2 m	3 m	4 m
2 L2	0.50<K≤0.63	–	1 Dm	1 Cm	1 Bm	1 Am	2 m	3 m	4 m	5 m
3 L3	0.63<K≤0.80	1 Dm	1 Cm	1 Bm	1 Am	2 m	3 m	4 m	5 m	–
4 L4	0.80<K≤1.00	1 Cm	1 Bm	1 Am	2 m	3 m	4 m	5 m	–	–

Class of operating time		Average operating time per day (in hours)	Calculated total operating time (in hours)
V0.06	T0	≤0.12	200
V0.12	T1	≤0.25	400
V0.25	T2	≤0.5	800
V0.5	T3	≤1	1,600
V1	T4	≤2	3,200
V2	T5	≤4	6,300
V3	T6	≤8	12,500
V4	T7	≤16	25,000
V5	T8	>16	50,000

The grade symbols are identical to those of FEM 9.511. (Rules for Design of Serial Lifting Equipment: Classification of Mechanisms)

Figure 6. Relation between ISO and FEM classifications.

As Indicated by Figure 6:

The left Section of Figure 6 shows how a Load Spectrum, 2 / L2 for example, can be selected based on the Cubic Mean Value. The right section shows how a Class of Operating Time, V0.25 / T2 for example, can be selected based on the average operating time per day. One could cross reference both of these selections in the center to arrive at a classification choice of 1C_m. The relationship between FEM and ISO Classifications is seen in the upper portion of Figure 6 where the ISO designations of M1, M2, M3, M4, M5, and M6 are listed below their FEM equivalent.

- Example: The FEM equivalent of an ISO M4 classification would be 1 Am.
- Example 2: A hoist that needs to lift approximately 70% of its W.L.L. (k=0.70) consistently and operate for approximately 2 hours each day would be classified as a 2_m. Knowing this, one could check the top portion of Figure 6 and see that their 2_m classification is equivalent to an M5 ISO classification.
- Example 3: A hoist that needs to lift approximately 20% of its W.L.L. (k=0.20) consistently and operate for approximately 1 hour each day would be classified as a 1C_m. Knowing this, one could check the top portion of Figure 6 and see that their 1C_m classification is equivalent to an M2 ISO classification.

4.0 Harrington's Lifting Motor Rating and Hoist Classification

4.1 Purpose

Section 4 discusses the Lifting motor Duty Rating and Hoist Classification given to Harrington's ER Hoists. Section 4.2 discusses Lifting Motor Rating and section 4.3 discusses Hoist Classification.

4.2 Lifting Motor Rating

ER Hoist motors achieve 60%ED and 60 minute which is the highest motor grade for hoists in FEM 9.682 "Design Standard for Lifting Device and Selection of the Motor."

Figure 7 shows a label found on the motor of a Harrington ER Hoist. At the center of this label is a row stating this hoist has an ED rating of 60% and 360 starts per hour.

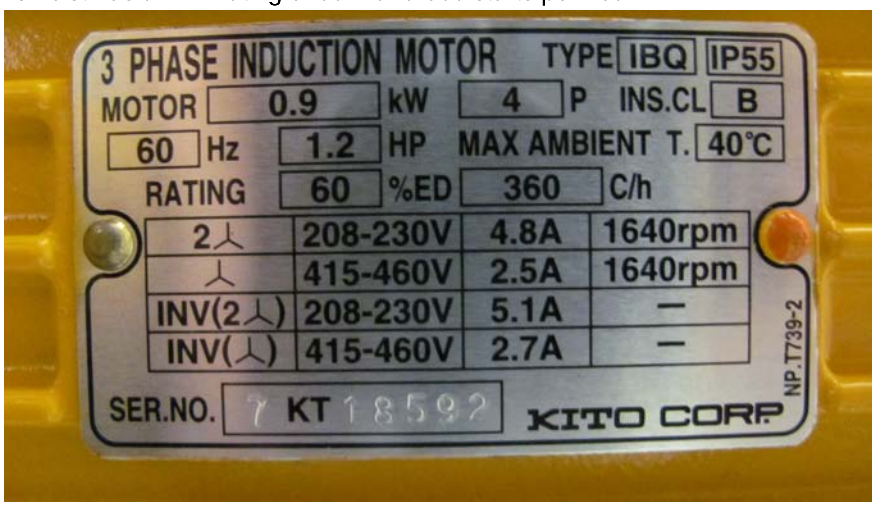

Figure 7. A Harrington ER Hoist Motor Label.

Harrington ER Hoist motors have Insulation Class B. This is indicated in the far right of the second row of information in Figure 7 and means that the highest allowable motor temperature is 130^{o}C (266^{o}F).

The Short Time Rating Cycle shown earlier in Figure 1 is an experiment designed to test a motor's ability to avoid surpassing its highest allowable motor temperature and avoid damage. Figure 8 on the next page represents the temperature rise experienced by a motor throughout the Short Time Rating Cycle. Harrington ER Hoist motors conform to this trend and do not surpass their highest allowable motor temperature by the time they have been running the test cycle for 60 minutes.

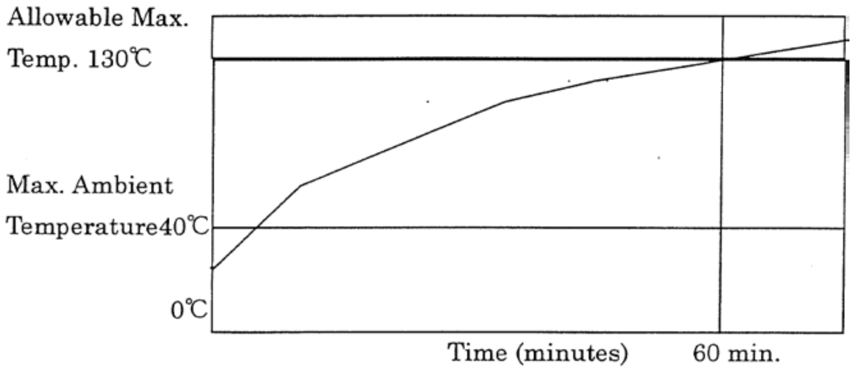

Figure 8. A Chart Illustrating Temperature Rise Over Time During a Short Time Rating Cycle

By successfully conforming to the test requirements, Single Speed Harrington ER Hoist motors earn themselves their 60 minute rating (Dual Speed: 30/10).

The conditions of the test are more severe than the conditions that would be seen during average continuous operation. This is due to the repeated starts and stops required by the test which produce current spikes and higher than normal temperature rises. It can therefore be concluded that Harrington ER Hoist motors are capable of successfully complying with the requirements of a severe test cycle and are more than capable of performing under normal operating conditions.

4.3 Hoist Classification

Figure 9 shows a label found on a Dual Speed Harrington ER Hoist. The top of the label reads that this hoist is in Hoist Duty Class H4, as most Harrington Hoists are. This is the highest Hoist Duty Class of the ASME HST Classifications shown in Figure 4.

Figure 9. A Harrington ER Hoist Label.

In order to earn the H4 designation, a hoist must be capable handling a high volume of loads with loads that are at or near the W.L.L. As indicated in Figure 4, it is also required that a hoist be capable of operating for at least 30 minutes per hour (50%ED) and capable of at least 300 starts per hour. Harrington Hoists are rated at 60%ED and capable of 360 starts per hour.

Therefore, it can be concluded that Harrington Hoists will, at the very least, meet the requirements of governing regulations as well as our customers and, in many cases, far exceed them.