SOLENOID APPLICATION DATA

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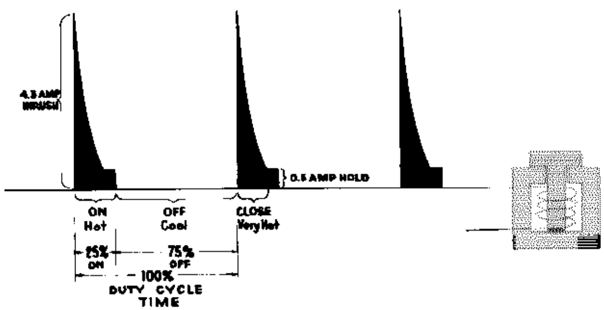
SOLENOID CYCLE RATE

The current flow into an AC solenoid under certain conditions can be shown as follows:



Each time the solenoid is cycled it receives a pulse of high inrush current which gradually declines as the plunger closes. In the full closed position, the solenoid is held energized by a low holding current flowing through the coil until the solenoid is de-energized.

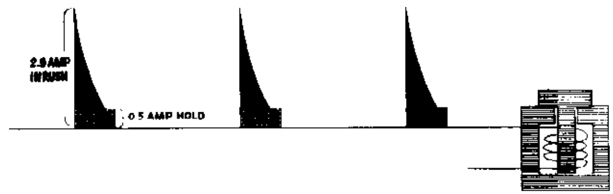
Current generates heat, and the area under each pulse or cycle represents heat generated in the solenoid. If the total heat generated from the continued cycling of a solenoid exceeds its ability to dissipate that heat, it will soon overheat and fail.

If we increase the cycles per minute of a solenoid, we increase the number of pulses in our illustration and increase the heat generated so you see the cycling rate is limited by the generated heat.

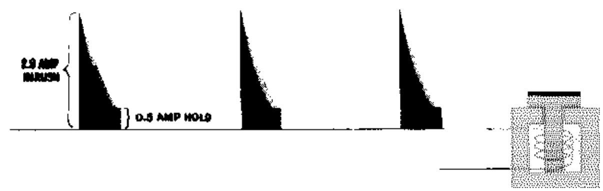
Obviously if we can do anything to reduce the size or duration of these pulses, we can reduce heat and permit faster cycling.

We know that the inrush current decreases with a decreased length of the solenoid's stroke so we can cut down heat by reducing the length of stroke.

The resulting chart looks like this. A lower pulse-less heat per each energization.



We also know that a solenoid's speed of closing is dependent upon the load it must move. If we reduce that load, we further reduce the heat generating area and our chart looks like this:



The shaded area represents the reduction in closing time (area of heating) affected by lightening the solenoid's load.

Obviously the percentage of "on time" versus "off time" will also affect the solenoid's temperature. This relationship is known as Duty Cycle. A 40% Duty Cycle is on 40%, off 60%.

Keep in mind that any solenoid can tolerate a higher input heat if it is mounted on a "heat sink" which will substantially increase its heat dissipating ability.

Decco will gladly supply you with data on maximum cycling rates at various strokes and loads.

SOLENOID FACT. . . or *fancy?*

COMMENT-The solenoid burned out because the bobbin melted and blocked the plunger.

FACT -Most bobbin material (Decco uses heat stabilized, glass-filled nylon) will not deform or flow until it has reached 500°F The only way to achieve this temperature is to first block the solenoid plunger in open position so that it is subjected to a continuous high inrush current. Standard solenoid coils are not designed for operation at temperatures over 105°C.

COMMENT-Solenoids have short lives.

FACT -This comment usually results from experience with an appliance grade solenoid in a high cycling application or even an Industrial Grade Solenoid of improper rating.

Decco solenoids' shock absorbing construction, tool steel anvils, silicon steel laminations and scientific heat dissipation assure unusually long service life.

COMMENT-The solenoid developed residual magnetism.

FACT —If you suspect residual magnetism in an Industrial Grade Solenoid, first check for mechanical freedom of the plunger.

The silicon steel used in Decco and most other Industrial Grade Solenoids does not develop residual magnetism. (Permanently magnetized plunger and field that refuse to separate.)

This is why "break away springs" commonly used in appliance grade solenoids are necessary.

COMMENT-The solenoid got old and lost force.

FACT -This could be true of appliance grade solenoids but the silicon steel used in Decco solenoids will not "magnetically age" or become permanently magnetized like cold rolled steel. If the coil has not shorted or burned out, the solenoid will maintain its original force. Check the solenoid for overheating, dirt or roughness which may be impeding the plunger and causing increased friction in the plungerguide.

COMMENT-High temperature coils are protection against burn out.

FACT -Any coil will burn out if heated above its rated level. When a solenoid is blocked open, the coil temperature quickly rises to above 200°C.

The rating of even Class H insulation is 180°C. A high temperature coil might conceivably buy a little more time before coil burn out.

High temperature coils are intended for use in high ambient temperature applications. Example: Where the ambient temperature plus the coil temperature rise may exceed the 105°C limit of standard Class A insulation.

COMMENT-A 60 cycle solenoid will run just as well on 50 cycles and vice versa.

FACT -A 50 cycle solenoid will run on 60 cycles but cannot develop rated force (approximately 75% at stroke).

A 60 cycle solenoid operated on 50 cycles will run hotter and may overheat.

50 and 60 cycle solenoids

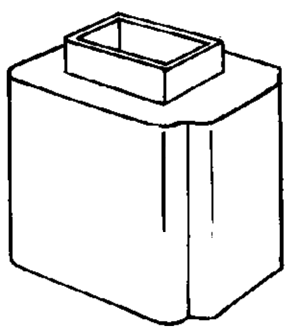
With the exception of Canada and most South American countries, nearly all foreign countries operate on a 50 cycle power supply.

Coils for Decco solenoids can be wound so that they may be used with either 50 or 60 cycle current. However, for best performance it is recommended that coils be wound for the specific frequency on which they will be used.

So-called "dual frequency" (50-60 cycle) coils are actually wound for 50 cycles and their use on 60 cycles is limited to applications where their reduced force is adequate to operate the mechanism.

Sometimes one coil can serve as a "dual frequency" coil if the 50 cycle operating voltage is lower than the 60 cycle nominal voltage. Example-120 volts at 60 cycles, 100 volts at 50 cycles.

In this case, the winding for both specifications is the same so the same coil can be used successfully in both applications.



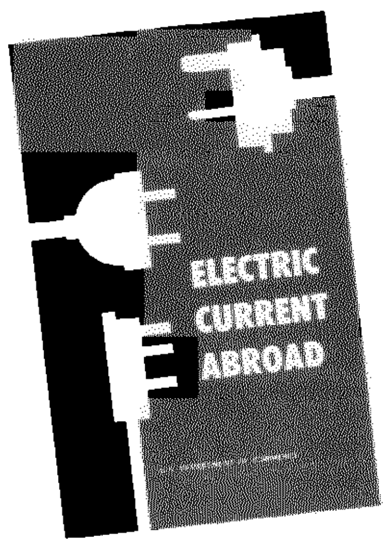
Looking at the situation in another way, the twenty extra volts available at 60 cycles will provide enough extra power to offset the power loss at 50 cycles mentioned in the previous paragraph.

Tapped or three lead "dual frequency" (50-60 cycle) coils are a more expensive but practical solution. These coils have one common lead, with a 60 cycle lead tapped in near the end of the coil and a 50 cycle lead at the coil's end. Such coils are usually wound for 60 cycle voltage at a multiple of 115 or 120 volts, with a 50 cycle tap at a multiple of 110 volts. Example- a coil could be wound for 50 cycles at 110 volts with a tap or third lead for 60 cycle, 115 volt operation.

Ideally a 50 cycle solenoid should be manufactured with more laminations in both plunger and field, but because of the limited demand for 50 cycle solenoids Decco as well as other manufacturers use a 60 cycle plunger and field, and alter the coil only.

This compromise results in a 50 cycle solenoid with slightly less than normal force. Force reduction is roughly 10% at 1/2 inch stroke and 5% at 1/4 inch stroke. Holding force is very little affected.

A 50 cycle power supply is not always available for pre-shipment testing of equipment before export. If this happens, 50 cycle power can be simulated on 60 cycles by adjusting your 60 cycle voltage to a level of 6/5 rated voltage.



Specifications for available power supply in, most foreign countries are given in a booklet titled, "Electric Current Abroad." published by U. S. Dept. of Commerce, Business and Defense Services. Available from the Superintendent of Documents, U.S. Government Printing Of- ;&Washington, D.C.

INDUSTRIAL GRADE VS APPLIANCE GRADE SOLENOIDS

Today's APPLIANCE GRADE solenoids will perform adequately in applications for which they are intended.

They can be used where anticipated service life does not exceed approximately 100,000 cycles, and where high operating temperature or a definite holding buzz are not objectionable.

APPLIANCE GRADE solenoid plungers usually run in brass liners or guides which wear through or break loose when subjected to severe or long use. This causes the plunger to stick and ultimately burn out the coil.

On the other hand, INDUSTRIAL GRADE solenoids, though higher in price (roughly double for equal ratings), can be used where much longer service life, cooler operating temperature and quiet operation are desired.

Due to the lower cost lamination material used in APPLIANCE GRADE solenoids, so called "break away springs" must be used to overcome the residual magnetism built up in the metal parts, and to break the plunger away from the field assembly when the solenoid is de-energized.

These "break away springs" are prone to break or come loose, blocking the plunger and causing coil burnout.

Decco INDUSTRIAL GRADE solenoids are made with more expensive silicon steel laminations which will NOT develop residual magnetism and require NO "break away springs" to free the plunger.

From the standpoint of efficiency and temperature build up, the following test of a Decco INDUSTRIAL GRADE solenoid and an APPLIANCE GRADE solenoid of equal rating is most revealing.

ACTUAL TEST RESULTS

	Decco Industrial Grade Solenoid	Applianc Grade Solenoid
Quiet Hold Force	18.1 lbs.	4.0 lbs.
5/16" Stroke Force	11.2 lbs.	10.9 lbs.
1/2" Stroke Force	10.5 lbs.	9.0 lbs.
Wattage	13.5 watts	28 watts
Ultimate Temperature	162 degrees	257 degrees

As you can see, the APPLIANCE GRADE solenoid required twice the wattage to produce the same force. The extra wattage was required by the cheaper steel used in the laminations and resulted in roughly twice the heat build up compared to the Decco INDUSTRIAL GRADE solenoid.

From a noise standpoint, the Decco solenoid has a much quieter hold as each unit has permanently silver soldered shading coils which cannot break loose or drop out, and which eliminate buzz or chatter.

Each Decco solenoid is individually tested for quiet hold, at rated voltage and load, before shipment.

SOLENOID FORCE and VOLTAGE

The pull-in force of a solenoid decreases rapidly as the voltage decreases below the coil nominal rating. On the other hand, as the voltage increases over the nominal value, the pull-in force increases, but the solenoid temperature may also rapidly increase.

LOW VOLTAGE From a low voltage standpoint, solenoid size selection should allow for adequate force at some arbitrary low voltage level. This will insure adequate solenoid force even during periods of low voltage and will prevent failure to pull-in and consequent coil burn out.

Design practices vary but low voltage levels are usually set at 85% or 90% of rated or nominal levels.

For convenience, Decco solenoid force ratings are listed in the catalog at both 100% and 85% of rated voltage.

Forces at other reduced voltages can be closely approximated by means of the following formula:

$$F_1 = F \times \left(\frac{E_1}{E}\right)^2$$

Where: F_1 = solenoid force at a reduced voltage E_1.

F = solenoid force at rated voltage E.

Forces calculated with this formula will be within 5% of measured forces down to 70% of nominal or rated voltage.

OVER VOLTAGE -The extra force resulting from over voltage (or voltage above the coil nominal rating) will normally last for short periods of time. Under these conditions the mechanical life of a solenoid will not be seriously affected.

The coil temperature rise and the consequent ultimate temperature of the solenoid will increase. Unless the ultimate temperature exceeds the class “A”, 105°C rating of the insulation, the application will be satisfactory. The solenoid temperature can be lowered by mounting on a surface, such as an aluminum plate, which will conduct the heat away.

AC SOLENOIDS ON DC

A solenoid designed to operate on alternating current can also be operated on direct current. There are, however, some limitations.

A solenoid operating on AC draws a high "inrush current" when the solenoid is open. As the solenoid closes, this current decreases to a low "holding current" when the solenoid is fully closed. For example, a Decco Model 01 solenoid draws an inrush current at 1/2" stroke of 1.12 amps. and a holding or closed current of only 0.23 amps.

This current characteristic of an AC solenoid is extremely important. The high inrush current provides a high initial force which is usually desirable to overcome the load on the solenoid.

On the other hand, when the solenoid is held closed, the current is at the low holding level. This low holding current generates very little heat, so the solenoid remains cool.

In short, an AC solenoid has a built-in current valve, which provides for high force pull-in and cool holding.

Now, suppose the Decco Model 01 AC solenoid is operated on DC. When this or any solenoid operates on DC, the current flow is constant regardless of whether the solenoid is open or closed. The inrush and holding current are the same.

Because of this constant current feature of DC, a compromise between pull-in force and holding temperature must be made. Specifically, if enough current is provided to give the same pull-in force as AC would provide, the solenoid may overheat if held energized. If the current is reduced to a level that will prevent overheating when held closed, the pull-in force will be greatly reduced.

Therefore the question of whether or not a given AC unit performs satisfactorily on DC power depends upon how pull-in force and overheating can be balanced.

Some applications may not require that the solenoid be HELD energized. In this case, an AC design unit might be operated on either AC or DC power. DC current could be supplied to give the high pull-in force, equal to the force obtained from AC power. Overheating during the brief energized periods on DC would not be a consideration.

In applications where the stroke is extremely short, an AC unit can usually be operated successfully on DC. This is because at short strokes on AC power, the inrush or open current is only slightly greater than the holding current. The constant current characteristic of DC will not be enough different to cause problems of pull-in force or overheating.

In many cases, AC solenoids can be operated on DC power with the addition of a switch and resistor. The switch is arranged to be opened when the solenoid closes. When the switch opens the resistor is in series with the solenoid coil. The addition of this resistance reduces the coil current so the solenoid can be held energized without burning out. A high current which will produce a high pull-in force is then possible.

DC SOLENOIDS ON AC

Within limits, DC solenoids can be operated on AC.

For reasons of economy and flexibility, DC solenoids are usually made with solid iron parts. When operated on AC, eddy current and eddy current losses are Introduced. These losses in solid iron parts are high, and high temperatures can be developed.

Therefore, the use of AC power on DC solenoids should be limited to applications where a low current is adequate, to prevent overheating. AC power is also practical where the solenoid is on and off in so short a time that the eddy current losses cannot generate excessive heat.

Also, if a DC unit is to be used on both AC and DC power, it should be equipped with shading coils. These coils, common on AC designs, keep the solenoid from buzzing when the AC sine wave goes through zero.

DC-design solenoids with shading coils are sometimes termed AC-DC units.

SOLENOID INSPECTION

An increasing number of companies are embarking on formal quality control programs which include thorough inspection of all purchased components. In the case of solenoids, confusion can be avoided if customer incoming inspection and test procedures are the same as those used by the manufacturer when rating the solenoids. In the interest of economy, only the most significant tests should be performed:

DIMENSIONAL CHECKS

Dimensional verification is straight-forward, and can be performed with little danger of misinterpretation.

PULL-IN FORCE

Most of the confusion in solenoid inspection lies in the area of force measurement. Lets clarify a few points:

1.) Solenoid force is simply the amount of load (or weight) the solenoid plunger can pull in when energized. Each stroke length has a different force rating, and force increases as stroke length decreases, so pay close attention to stroke length during testing.

2.) During force tests, an AC solenoid must be free to close immediately when energized. No solenoid can maintain pull-in force when energized and blocked open. If an AC solenoid is not permitted to close in approximately ten milliseconds, the coil will overheat and force will decrease substantially.

3.) Detroit Coil Company and most other solenoid manufacturers test and rate solenoid force using an air cylinder to provide the load. Unlike a weight, which offers an inertial starting resistance, these devices have negligible inertia. The use of weights for testing will result in force readings approximately 10% below the air cylinder ratings. A spring load, however, will act like an air cylinder, since it offers no inertial load.

FORCE AT ELEVATED TEMPERATURES

Since solenoid pull-in force varies with temperature, tests should be run at the temperature in which the solenoid will be expected to perform. If the temperature is elevated, unfortunately, this is more easily said than done. Unless the setup is made very carefully, errors can occur.

Decco solenoid forces are rated at 25°C (room temperature). To simplify the procedure, we suggest making a careful correlation of forces, under strict test conditions, at both the elevated temperature and 25°C using the same solenoid. Once this correlation is established, subsequent tests can be conveniently and accurately performed at room temperature.

QUIET HOLD CAPACITY

An AC solenoid's quiet hold capacity is the maximum load it can support, when closed, without an excessive 60 cycle buzz or hum. Like pull-in force, quiet hold capacity varies with voltage and temperature, so be sure to run the tests at specified voltage and temperature.

Quiet hold capacity is also affected by the smoothness and alignment of shading coil surfaces, so make sure the surfaces are clean and burr-free before testing. Since the solenoid is already closed, no movement of the load is involved, and a weight, air cylinder, or spring tester can be used with equal results.

DC RESISTANCE

Another commonly-checked electrical value is DC resistance of the coil which is subject to a tolerance due to variation in wire tension during coil winding. Since DC resistance is widely affected by coil temperature, tests should be made at a specific temperature. Decco standard coil resistance is measured at 25°C (room temperature).

TEMPERATURE RISE MEASUREMENTS

The most convenient and accurate method of measuring solenoid temperature rise is the DC resistance method. Here the change in resistance, (or the ratio of hot to cold resistance), is converted into the rise in temperature using the appropriate chart. Detroit Coil Company will furnish such charts.

Temperature is seldom uniform throughout the coil, and any measurement made by thermocouples can be misleading depending on where the thermocouples are located in the coil. The resistance method represents an AVERAGE temperature throughout the coil.

When checking temperature by the resistance method, an accurate resistance bridge should be used. A slight error in resistance reading will result in a relatively large temperature error.

Solenoid temperature rise will vary with the ambient, or starting temperature. Therefore, the rise should be measured over the actual or specified ambient. We recommend soaking the solenoid for several hours until the temperature stabilizes.

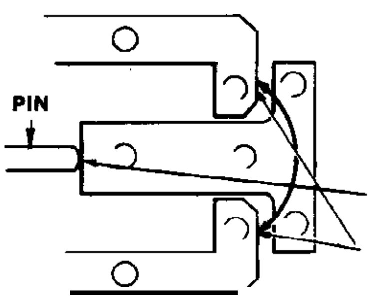
CURRENT AND WATTAGE

Solenoid wattage and holding current can easily be checked if it is deemed necessary.

SOLENOID APPLICATION

The selection of solenoids for most applications is generally a pretty straight-forward process. Best results can be obtained by considering the following points:

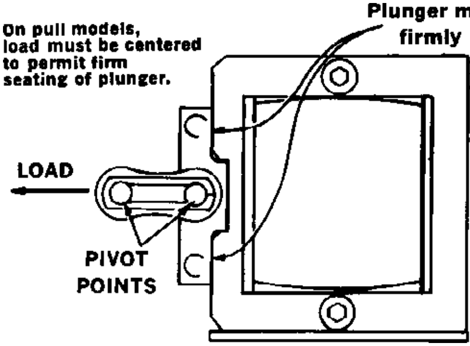
1. Horizontal and vertical mount push and pull solenoids all provide satisfactory performance in normal applications. However, mounting a solenoid so that the plunger moves in a vertical plane will minimize wear between plunger and coil liner. Also, push models usually seat better and are less likely to develop alignment problems.



2. Use the shortest possible stroke to reduce impact force and solenoid wear.

3. Since high cycling rates raise a solenoid's temperature and reduce its force, be sure to consult Decco's cycle rate curves to avoid solenoid overheating in high cycle rate applications.

4. Be sure that the plunger moves freely in a straight line. Any side loads can cause binding, undue wear or solenoid buzz.



5. Solenoid force drops when line voltage drops. Always select a solenoid large enough to move the load at the minimum design voltage. Decco graphs show solenoid force at 100% and 85% of rated voltage.

6. Make sure ambient temperature plus solenoid temperature rise is well within the maximum insulation rating for the solenoid. If ambient exceeds approximately 40°C, special high temperature coil insulation may be needed.

7. Pins on push solenoids should be made of non-magnetic stainless steel or heat treated beryllium copper. Magnetic pins will short out the magnetic field and reduce solenoid force at least 10%. If you have to use a magnetic pin, it may be necessary to use a larger solenoid.

RESIDUAL MAGNETISM IN SOLENOIDS

It is well known that cold rolled steel and many other metals can become permanently magnetized when placed in a magnetic field. When these materials are used in a solenoid, the solenoid's plunger will be attracted or held against the field or "C" frame even after current stops flowing in the coil. This magnetic attraction is called "Residual Magnetism."

The phenomenon by which iron or cold rolled steel becomes permanently magnetized is known as "magnetic aging." Magnetic aging of a solenoid's metal parts increases electrical loss and causes high operating temperatures which can be undesirable. The rate and degree of magnetic aging is a function of the time in the magnetic field. Consequently, a solenoid that is held energized for long periods of time will age more and faster than one which is rapidly cycled off and on.

Residual magnetism can develop in both AC and DC solenoids, and a solenoid plagued by residual magnetism requires extra force to open after it has been de-energized, which decreases the solenoid's capacity to overcome a given external load.

One solution to residual magnetism is the use of break-away springs which kick the plunger out when the solenoid is de-energized. These springs are a drawback, however, not only because their life is limited, but because they rob the solenoid of force capacity since they must be overcome when the solenoid closes.

By far the best solution is Decco's use of silicon electrical steel for plungers and "C" frames. While more expensive, silicon electrical steels will not age magnetically and develop residual magnetism regardless of how long they are subjected to a magnetic field.

Decco overcomes residual magnetism in DC solenoids by not permitting metal to metal contact at the bottom of the plunger. A thin non-magnetic shim or spacer is sometimes used.

TRANSIENT SUPPRESSION

As a solenoid is a highly inductive load, severe spikes or transients can be produced during switching.

When solenoids are used with solid state components, some method of protecting these components must be used.

The simplest and most economical means is a commercially available device called a transient suppressor which is connected in parallel with the solenoid coil. The device conducts a current above a specified voltage value, thus allowing the spike to flow back into the coil until it dissipates.

A so-called non-polarized suppressor can be used on either AC or DC circuits. Polarized units can be used on DC circuits only.

Transient suppressors are made in various sizes. They are rated by the voltage value at which they become conductive. For any Decco solenoid, a suppressor of capacity slightly above the nominal voltage should be used.

Transient suppressors are commercially available such as MOV varistors, manufactured by General Electric, or by International Rectifier.

For example, a Decco Model 17 solenoid operated on a nominal 120 volt power supply would require GE suppressor number V220MA2A which becomes conductive at 132 volts.

HOW TO WRITE SOLENOID PERFORMANCE SPECIFICATIONS

The purpose of performance specifications is to define a solenoid's characteristics to assure its optimum performance in a given application. Unnecessary specifications should be eliminated to reduce engineering time and minimize the amount of inspection which must be performed each time a shipment is received.

Any performance specifications that involve elevated ambients, special voltages, heat sinks or extended cycling can be converted to equivalent specifications which permit incoming inspection at *standard conditions.*

For example, actual operating conditions might require a certain force at a specified elevated ambient temperature, cycling rate and voltage on a heat sink. The Decco solenoid that meets these specifications will have a corresponding force characteristic under standard conditions. Once several solenoids have been tested and found satisfactory under the application's actual operating conditions, equivalent performance characteristics should be noted for the same solenoids at room temperature (25°C.) and nominal voltage, not on a heat sink.

When a solenoid must deliver a certain force at a voltage below the nominal rating, the unit will have a corresponding force at nominal voltage.

Another application might require a certain solenoid force at a voltage *above* the nominal rating without exceeding a specified coil temperature rise. A solenoid which meets these requirements will have a corresponding force and temperature rise at nominal voltage.

Once all these equivalents for corresponding performance characteristics (at standard conditions) are established, specifications can be written based on them. Incoming inspection can then be easily and accurately made without elevated ambients, special voltages, heat sinks or extended cycling.

When the application requirements have been defined, Decco will simulate these conditions and specify the proper solenoid.

One *word of caution.* Due to manufacturing tolerances, several solenoid samples should be tested to arrive at average values.

With further thought towards simplifying specifications and incoming solenoid inspection while still assuring proper performance, the following points should be considered –

(1) VOLTAGE – This specification would include the nominal or rated value plus a tolerance. Common tolerances are 85% and 100% of nominal or nominal ±5%. This tolerance should be held as close as possible. A low voltage limit may require a larger solenoid, since force drops off as the voltage goes down. At high voltage limit a solenoid will generate excessive heat which causes a reduction in solenoid force. This, too, may require a larger solenoid, a reduction of the solenoid load, or some other compromise.

(2) FREQUENCY – Usually 50 or 60 Hertz. Occasionally a small tolerance is added.

(3) COIL INSULATION CLASS – Non-metallic materials used in solenoids are rated by manufacturers or recognized agencies according to the maximum temperature under which the materials will provide a specified life. No one agency rates all materials.

Temperature ratings are: Class A – 105°C., Class B – 130°C., Class F – 155°C., and Class H – 180°C., maximum ultimate. Insulation above Class A should be avoided, if possible, since high temperature materials are expensive. Also, operation at high temperatures reduces solenoid force.

(4) CONTINUOUS OR INTERMITTENT DUTY – A continuous duty solenoid can be held energized at specified voltage and ambient temperature without exceeding specified coil temperature.

An interminent duty solenoid must be de-energized to prevent coil temperature from exceeding specified limits. When intermittent duty solenoids are specified, the time-on and time-off must be stated. Time-on divided by total time is known as the duty cycle and is commonly expressed as a percent.

(5) MAXIMUM PULL-IN FORCE – The maximum force against which a solenoid will close. The term "close" means a positive, quick close in 15 or less milliseconds on a small solenoid. If a solenoid chatters and hesitates before closing, the load is too great and the solenoid will overheat after repeated operation.

Pull-in force is an important specification. It is dependent upon stroke, solenoid temperature, voltage, cycling rate, wattage and almost every other variable.

The pull-in force measured with a dead-weight will be less than the force measured with a spring load, because the weight has inertia which must be quickly overcome. A spring has no inertia.

All the factors affecting pull-in force can be covered if the type of load (weight or spring), voltage, stroke and coil temperature are specified. Cycling rate and duty cycle need not be specified if coil temperature is specified.

(6) QUIET HOLD – The amount of load a solenoid can hold without objectionable hum or buzz. This is a value judgment. Quiet hold is the product only of the accuracy of the machined surfaces between plunger and field. It will be the same for a dead-weight or spring load.

A complete solenoid specification should include quiet hold, since it is independent of all factors except machining accuracy.

BREAKAWAY FORCE is the force required to push or pull the plunger away from the field stack when the solenoid is energized. This is not a necessary specification. First, it is not a normal solenoid operating mode. It is as subjective as quiet hold since the solenoid will become progressively noisier as greater breakaway force is applied. The maximum acceptable noise is the important factor in each case, and noise is a value judgment only.

(7) TEMPERATURE RISE – The increase in temperature a solenoid experiences when it is operated under specific conditions. Temperature rise is dependent upon ambient temperature, stroke, cycling rate, voltage, duty cycle and mounting.

Usually a solenoid should be allowed to operate at specified conditions for several hours before it stabilized at its maximum temperature.

Temperature rise is most conveniently measured by the change-in-resistance method which indicates the average temperature of the coil winding. If other methods are used, they should be specified.

Ambient temperature plus temperature rise equals the solenoid ultimate temperature.

(8) DC COIL RESISTANCE – This value is useful only in identifying coils. It is limited in usefulness because coils of nearly the same voltage may have the same DC resistance. DC coil resistance must carry a tolerance of ± 10% to allow for wire winding tension and other variables,

(9) HOLDING CURRENT – Current flowing in the coil when the solenoid is closed and energized. Holding current increases with applied voltage and decreases as coil temperature increases. These variables should be specified with holding current,

Holding current values will indicate coil losses only. Wattage values give a complete measure of total solenoid losses, and, therefore, are preferred, However, these losses produce solenoid temperature rise, so if this value is specified, both coil current and wattage are not really necessary.

(10) MAXIMUM WATTAGE – This is measured when the solenoid is closed. It is the most convenient means of checking the coil for shorted turns. Wattage also gives an indication of total solenoid losses. These losses create the solenoid temperature rise. Wattage increases with voltage and decreases as solenoid temperature increases.

Losses are dependent upon solenoid materials and construction. Wattage measurement indicates the uniformity of these factors in addition to the presence of shorted coils.

Laminated solenoid wattage must be measured with a low power-factor watt meter. (One for 25% or less.) A common or high power-factor meter will give incorrect, usually excessive readings.

TYPICAL DECCO SOLENOID PERFORMANCE SPECS

(1) Decco solenoid model ____________________

(2) Nominal voltage - Minimum ____ Maximum ____

(3) Frequency ____________________

(4) Solenoid to be Continuous ( ) or Intermittent ( )
If intermittent, Time on_____ Time off_______

(5) Insulation class ____________________

The following measurements should be made at nominal voltage and specified frequency with solenoid temperature stabilized at 25°C.

(6) Maximum quiet hold ____________________

(7) Maximum pull-in force at ______stroke _________
(Specify spring or dead-weight load) __________

(8) DC coil resistance ____________________

(9) Temperature ________(Specify heat sink, if used) ____________________

(10) Maximum wattage ____________________