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WIRELOCK®

WIRELOCK® TECHNICAL DATA MANUAL

MANUFACTURED BY MILLFIELD ENTERPRISES (MANUFACTURING) LIMITED
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Appendix C

An ISO 9001 Certified Company

the Crosby group, inc.
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April 4, 1989

TECHNICAL BULLETIN NO. 1

Guidelines for re-use of Spelter Sockets (416 and 417)

The use and inspection of Spelter Sockets is the responsibilty of the user.

1 PROCEDURE FOR REMOVING SPELTER CONE

A. Cut the rope close to the nose end of the socket and press the cone out of the socket.

B. We do not recommend the use of heat to remove the spelter cone for metallurgical medical and environmental reasons. (If socket preheat is used in subsequent speltering operations, the socket should not be heated above 200°F)

II SELECTION or SOCKETS FOR RE-USE

A. Use only sockets that:

1. Do not show discolouration from excessive heating.
2. Do not show any signs of welding

B. Select only sockets that have been cleaned and passed a Magnetic Particle Inspection by a qualified technician and performed in accordance prescribed by ASTM E709.

C. Select only sockets that do not show any signs of overloading or wear on the socket or pin. i.e., elongated pin holes, undersize pins. etc.

D. Select sockets that are free from nicks, gouges and abrasions. Indentations may be repaired by lightly grinding until surfaces are smooth provided thay do not reduce the dimension by more than 10% of the nominal catalog dimension.

E. Select sockets that are not distorted, bent or deformed. Sockets having these indications shall not be re-used.

III. PROCEDURES FOR SPELTERING SOCKETS

A. The proper procedure for speltering sockets can be found on Pages 112 - 116 of the Wire Rope Users Manual, Second Edition, and in American Petroleum Institute (API) Recommended Practice 9B (RP 9B), Ninth Edition, May 30, 1986, Pages 10 - 13.

IV. PROOF TESTING

A. We recommend the socketed assembly be proof tested at (2) two times the Working Load Limit (WLL) assigned to the socketed assembly.

Surface area of wire is vital, especially in the highly loaded section at the neck of the socket. From a quality point of view the broom should be opened right down to the seizing. Very often we see brooms which look very pretty and are nicely opened at the top but the strands remain substantially closed near the seizing. This state of affairs does not produce a quality assembly, even though it may break the rope.

One further point on the production of a quality assembly, is that care should should be taken to ensure that the neck of the socket has been sealed with clay or putty. Any leaks could cause voids in the neck area of the socket. These voids are able to form because the resin starts to gel - harden - in the centre of the mass and if resin leaks out at the neck of the socket, the resin above it during gel is no longer liquid and is, therefore, unable to flow down to fill the void.

It is not necessary to hook wires when resin socketing except in the case of coarse construction wire rope such as 6 x 7.

In use, the resin socketed assembly offers a higher achievable tensile strength and a better fatigue performance of the assembly. In general, this can be attributed to two factors; the excellent penetration of resin, ensuring a complete cone and, secondly, the fact that there is no annealing of the wires due to heat from molten metal. A further benefit that is derived from the lack of heat, is that the lubricant in the rope remains intact and is not burned off. It is an easy matter to replace the lubricant on the outside of the rope but very difficult to replace the lubricant in the centre of the rope. It is, as it does not require any heat, acid etching or neutralising, an inherently safe method, for the rigger to use both in the shop and on site. Finally, the quality and reliability of this method is, without question, superior to other methods of socketing. It also avoids the damage caused to ropes by other mechanical methods of attachment of end fittings, which may affect both the tensile and fatigue potential.

Bibliography.

Dodd J.M.	Resin As A Socketing Medium	Wire Industry	- May 1981
Chaplin Dr C.R. Sharman P.C.	Load Transfer Mechanics in Resin Socketing	Wire Industry	- Oct 1984
Cordon Dr C.R.R.	The Use Of Resin For Man Riding In Mine Shafts	IMEMME	- March 1987

Detailed Instructions for the use of Wirelock®

With Strand or General Purpose Wire Rope

These instructions explain the proper use of WIRELOCK® for socketing wire rope terminations. When reading and following these instructions, pay close attention to warnings and safety information presented in bold print.

For maximum safety and efficiency, use **WIRELOCK®** only as instructed.

1. Warning on Correct Application of WIRELOCK®

It is very important when deciding upon the use of **WIRELOCK®** to note the following:

WARNING

- **Incorrect use of WIRELOCK® can result in an unsafe termination which may lead to serious injury, death, or property damage.**
- **Do not use WIRELOCK® with stainless steel rope in salt water environment applications without reading and understanding the information given on page 7.**
- **Use only soft annealed iron wire for seizing.**
- **Do not use any other wire (copper, brass, stainless, etc.) for seizing. Never use an assembly until the WIRELOCK® has gelled and cured.**
- **Remove any non-metallic coating from the broom area.**
- **Sockets with large grooves need to have those grooves filled before use with WIRELOCK®.**
- **Read, understand, and follow these instructions and those on the product containers before using WIRELOCK®.**

2. Safety and Health Precautions for Using WIRELOCK®

It is important that certain precautions be taken when using **WIRELOCK®** for a wire rope socket termination. When using the product be sure to read information on product containers and note the following:

CAUTION

- **WIRELOCK® resin, in liquid state, is flammable.**
- **Chemicals used in this product can give off toxic fumes and can burn eyes and skin.**
- **Use only in well-ventilated work areas.**
- **Never breathe fumes directly or for an extended time.**
- **Always wear safety glasses to protect eyes.**
- **Always wear gloves to protect hands.**
- **Avoid direct contact with skin anywhere.**

3. Selection of Socket

3.1 **WIRELOCK®** is recommended for use with sockets that comply with International, European or National (ISO, CEN) Standards.

3.2 **WIRELOCK®** as with all socketing media, depends upon the wedging action of the cone within the socket basket to develop full efficiency. A rough finish inside the socket may increase the load at which seating will occur. Seating is required to develop the wedging action.

3.3 Measure the rope ends to be socketed. The rope end should be of sufficient length so that the ends of the unlaid wires (from the strands) will be at the top of the socket basket.

3.4 Next, apply the seizing one (1) socket basket length from the end of the rope minus one (1) rope diameter. The length of the seizing must be at least two (2) rope diameters long. Additional information can be secured from your Wire Rope Users Manual or your Wire Rope Manufacturers Catalogues or National Standard.

Seizing wire should be a soft annealed iron wire.

Seizing of Wire Rope

3.5 Plastic coated or plastic filled wire ropes must have all plastic material (non-metallic materials) removed from within the broomed area.

3.6 The socket basket should be examined prior to use and loose scale, dirt or grease removed.

Do not use oversized sockets for Wire Rope.

3.7 When socketing Strand, the time honoured method of one size up when choosing the socket is generally still applicable in the vast majority of cases. However, caution should be exercised as tests have shown that the length of the socket basket should be five (5) times the strand diameter or fifty (50) times the maximum wire diameter, whichever is the greater.

3.8 **Inserting the broom into the socket.** There are two procedures that can be used to position the broom within the socket. The rope can be inserted into the socket prior to brooming. Subsequently the socket can be pulled up over the broom. The second method requires that the broom is closed and compacted to enable it to be inserted into the socket without damaging the rope.

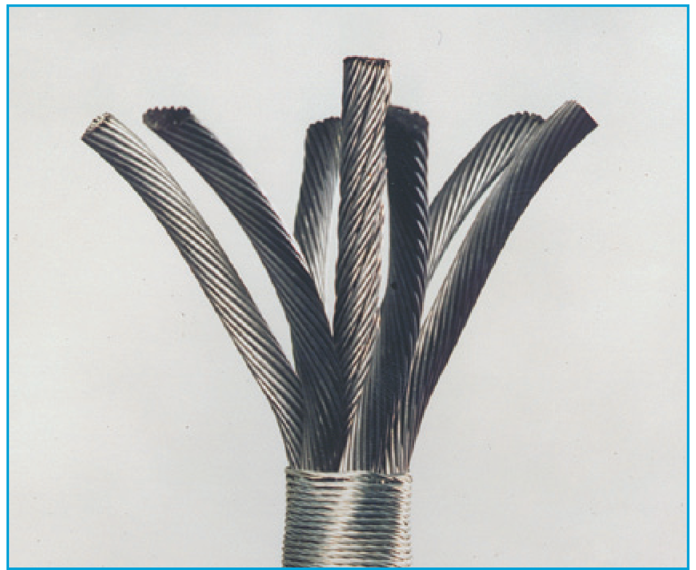
For detailed explanation of Resin Socketing of Steel Wire Rope, see Page 19.

4. Preparation of Broom

4.1 The rope is secured in a vice directly below the seizing to allow the strands to be unlaid to the seizing. They should be bent outwards to a total included angle not exceeding 90 degrees (Fig 1)

4.2 Internal leakage of resin in ropes 75mm (3") in diameter and larger can occur because of gaps between strands and the IWRC (Independent Wire Rope Core). These gaps should be sealed (before brooming), by pushing small plugs of the sealing compound down into the served portion.

4.3 If the rope has a fibre core, it should be cut out ensuring that the remaining fibre core extends ½ rope diameter into the bottom of the socket. In the case of fibre cores, resin is the preferred socketing medium.



Unlay wire rope so that angle does not exceed 90° (Fig 1)

4.4 If the rope has an IWRC, the IWRC shall be completely unlaid to form part of the broom.

4.5 All the wires in each strand and in the IWRC must be unlaid completely down to the seizing to form a broom, being careful not to disturb or change the lay of the wires and strands under the seizing band. The wires should not be straightened.

Brooming is one of the most critical parts of any socketing operation.

Note: The wires must be unlaid from the end of the rope to the seizing because a good fill of resin must occur to the bottom (small end) of the socket (Fig 2). **Most of the load capacity of the termination is concentrated in the bottom one third of the socket.**

We now have to consider two different scenarios to establish the key to this mechanism. In the first case, when the load is applied, the wire slips at the resin/wire interface before the cone slips at the cone/socket interface. In the second case upon application of the load the cone slips in the socket/resin interface before the wire slips within the resin.

In the first case, we have a disaster, as the rope will pull out. In the second case we have success, as the rope will break. What is it that determines which will occur?

Assuming that the coefficent of friction between the wire and the resin and the resin and the socket are of the same order, (an over simplification, but it does produce a simple model), the factor that determines which of the above scenarios will occur is the relationship between the surface area of the wire (S1) and the surface area of the inside of the cone (S2). If S1 is greater than S2 then the cone will seat and the rope will break. If S2 is greater than S1 the assembly will fail.

If, for example, we take a 13mm diameter 6 x 19 IWRC rope the relationship between S1 and S2 is of the order of 6:1, for a 36mm diameter 6 x 36 IWRC 9/:1 and for a 52mm diameter 6 x 41 IWRC 10:1. These figures give an indication of the margins of safety involved when resin socketing is employed. It also shows that the degreasing would have to be disastrously bad to reduce the coefficient of friction at the wire/resin interface to a critical level. One factor that has been ignored in this simple model, is that the unstraightened wires in the broom produce deformation forces when any attempt is made to induce slip thus increasing the grip of the resin on the wire and giving a further factor of safety. This wire in the cast cone, also tends to prevent any significant degree of axial extension of the cone during loading and the cone remains almost a constant length.

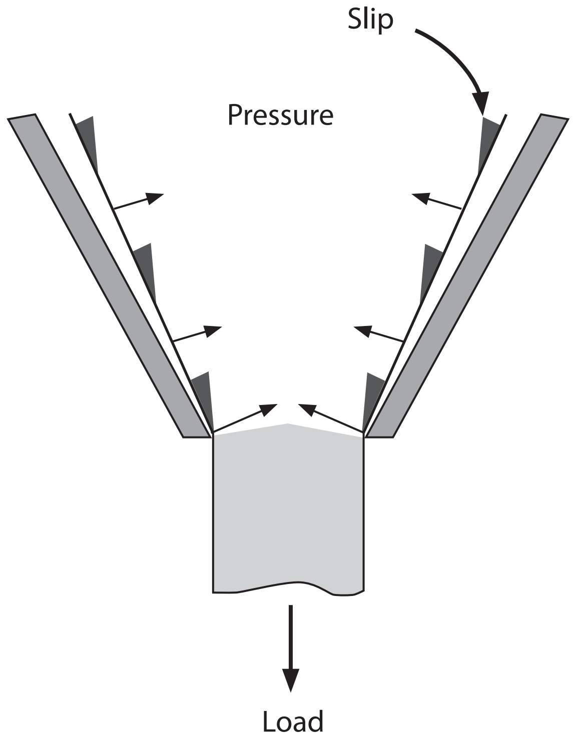
It would be useful at this point to examine the Federal Specification socket which has grooves or rings internally. It is obvious, that these rings must shear before the "locking" mechanism can operate and as such, are a hindrance to that process. Incidentally, in the case of zinc and white metal, this rupturing of the rings is also required before the rope will break. The only justification for these rings is to stop the cone "backing out" of the socket. In fact, once "seating" of the cone within the socket has occurred, it is not reversible and the cone is then locked into position.

This irreversibility offers the bonus that the stresses created within the socket are fixed and because there is no fluctuation, it follows that the opportunities for fatigue within the socket are reduced.

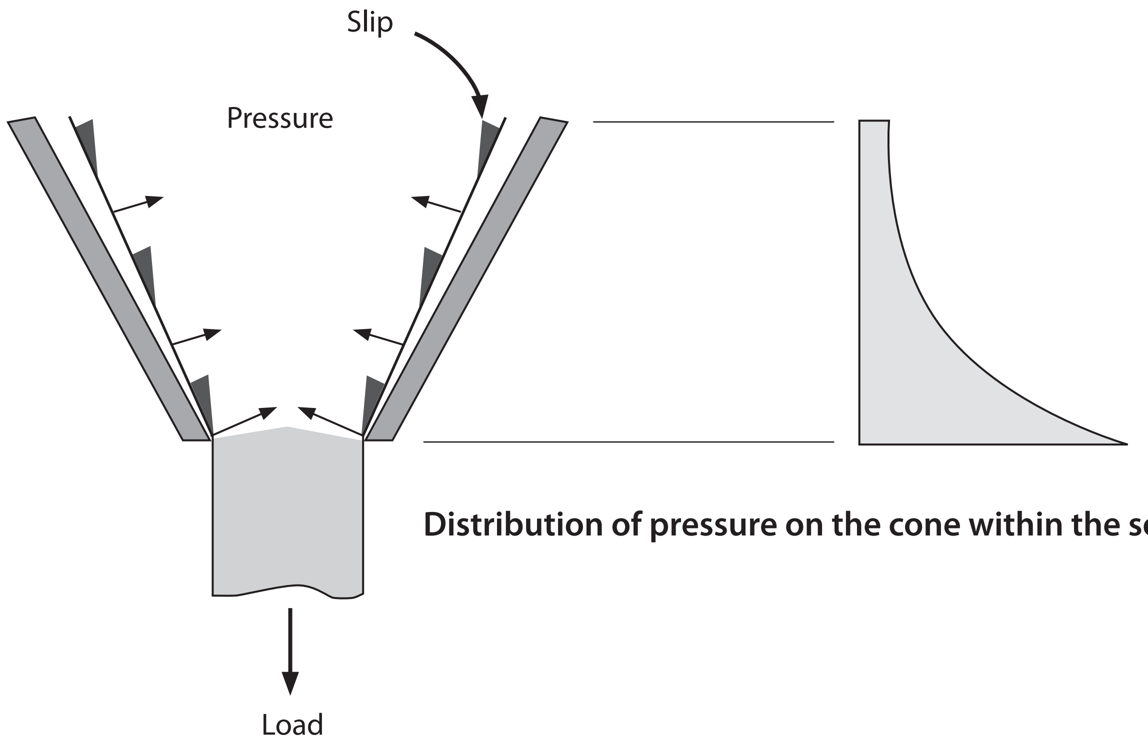
Let us return to the question of clean and uncleaned wire. A series of tests were carried out by A.I.F. in France, in which two samples of each of a series of rope sizes and constructions were broomed. One sample was degreased with trichlorethane and the other sample was left uncleaned.

Both samples went on to achieve the full breaking strength of the rope and almost identical breaking loads were achieved.

This highlights the fact that the frictional grip on the wires is highly efficient. If we take an overview of the whole situation it becomes apparent that the key operation in the resin socketing process is the brooming of the rope. Indeed this operation is vital for zinc and white metal as well.



Load causes the cone to slip at the socket interface and the pressure generated locks the cone within the socket
Fig IV



Distribution of pressure on the cone within the socket

Fig V

If we examine the forces present in Fig IV, we can see that when load is applied, the cone will seat progressively generating forces normal to the socket face. These forces are transmitted through the resin to the wire surface. We are, in effect, creating a wire reinforced composite wedge on the end of the rope, which is capable of withstanding the ultimate strength of the rope.

4.6 Except in the case of wire ropes of coarse construction e.g. 6 x 7, it is not necessary or desirable to hook the wires in the broom. When the rope contains large numbers of wires, hooking the ends causes congestion within the socket and can create penetration problems for the socketing medium although this is less of a problem with resin than with zinc or white metal.

4.7 The open broom shall be thoroughly cleaned (degreased). **Be sure that the cleaning is confined to the broom and does not extend to the rope beyond.**

Properly Broomed Wire Rope (Fig 2)

Incorrectly Broomed Wire Rope

4.8 The method of cleaning will depend on the lubricant and / or coating on the wire.

4.9 The methods and materials used for cleaning should comply with the current Environmental Protection regulations.

4.10 Consult your Wire Rope supplier or the Wire Rope Manufacturer for recommended materials and methods.

4.11 Do not clean the Wire Rope broom with acid, soda, methol hydrate, or acetone. A flux should not be used.

4.12 The wire rope broom, after cleaning and drying, should be kept in an upright position to prevent any grease, or mixture of grease and cleaner, from running back down from the main body of the rope and contaminating the clean wires.

5. Positioning of Broom and Alignment of Socket

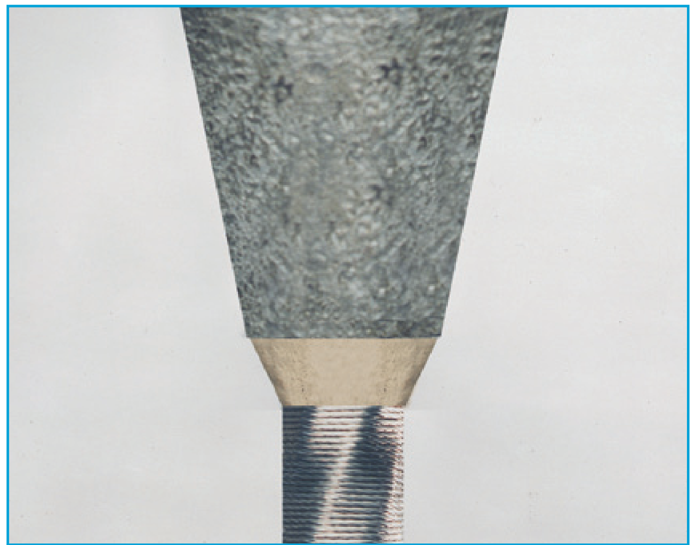
5.1 The broom should be inserted into the socket using one of the methods described in 3.8. Place rope in a vertical position with the broom end up. It is recommended that there be thirty (30) rope diameters below the socket before any bending occurs in the rope, or twenty (20) rope diameters if securely clamped to a beam.

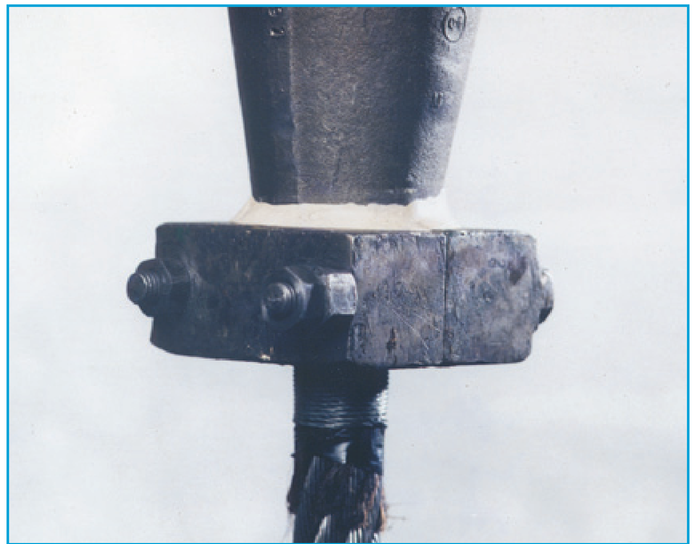
Make certain the broomed wires are uniformly spaced in the basket, with wire ends at the top edge of the basket, (Fig 3), and that the axes of the rope and the fitting are aligned. A centralizing clamp should be used to assist in the alignment of the axes of the socket and the rope (Fig 4 and Fig 5).

Correct alignment will avoid premature failure of the assembly due to unequal loading of the wires.


Properly positioned broom with the wire ends protruding slightly (Fig 3)

5.2 Plasticine or clay based putty, i.e. window or glazing putty, is required to seal the base of the socket prior to pouring, thus preventing resin leakage which may cause voids (Fig 4 and Fig 5).


Axes of socket and rope properly aligned and sealed with plasticine (Fig 4)


Clamp used to align rope and socket before sealing with plasticine (Fig 5)

6 Materials

6.1 Always check the expiry date on the cans. Never use out of date material. **WIRELOCK®** should be stored in a cool (10°C - 24°C) dry place.

6.2 **WIRELOCK®** is formulated for mixing and pouring in the ambient temperature range; from -3°C to 35°C (27°F - 95°F). At lower temperatures the gel time will increase. Below 9°C (48°F) the gel time of approximately 20 minutes can be maintained by the use of booster packs.

CAUTION

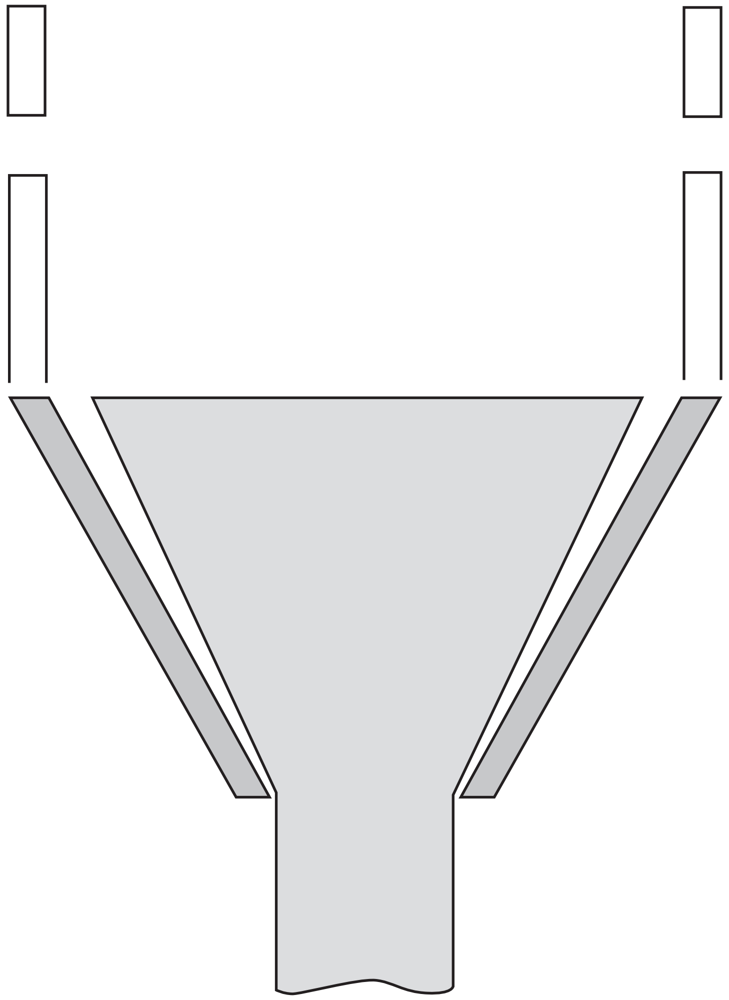
- **Chemicals used in this product can give off toxic fumes and can burn eyes and skin.**
- **Always check the expiry date on the cans. Never use out of date material.**
- **Use only in well ventilated work areas.**
- **Never breathe fumes directly or for an extended time.**
- **Always wear safety glasses to protect eyes.**
- **Always wear gloves to protect hands.**
- **Avoid direct contact with skin anywhere.**

6.3 At ambient temperatures below 9°C (48°F) and above 2°C (35°F), one (1) booster pack should be used. Below 2°C (35°F) and above -3°C (27°F) , two (2) booster packs should be used. The booster pack compensates chemically for the slower gel time experienced at lower temperatures. In order to comply with all the approvals granted, **WIRELOCK®** should not be mixed and poured at temperatures below -3°C (27°F). Knowing the ambient temperature is useful, however, it should be remembered **WIRELOCK®** will for some time afterwards tend to cure according to the temperature at which it, the socket and the wire rope were stored. The temperature of the socket and the rope should conform to

The mechanism of this movement and wedging action were investigated by looking at the distribution of pressure through the socket. This showed that approximately two thirds of the total pressure within the socket was concentrated in the bottom third of the socket. Whilst pressure at the top of the socket was very low indeed.

It is necessary to explain why any movement is possible within the socket and to link it with the pressure distribution findings above.

When the resin is first poured into the socket there is a perfect match between the shape of the socket and the resin cone. Once the resin has cured, however, shrinkage occurs and in an exaggerated form the effect is as below. (Fig III)



Exaggerated Relationship between Cone and Socket after the Resin has cured
Figure III

When the load is applied to the rope, any adhesion of the resin to the socket will shear and the cone, which is now slightly smaller, will begin to engage the socket wall at the neck of the socket, thereby generating pressure. Although it still retains a high modulus, the resin in contact with the socket is subject to plastic deformation and some flow is possible, allowing more of the cone to share in the loading process. This participation in load bearing diminishes as we proceed up the cone.
See figures IV & V.

The graph shows that high bond strengths are achievable between the resin and the wire and that shrinkage of the resin and the inclusion of hard silica in the resin gave a very high frictional grip on the wire. The classic slip/grip peaks and troughs on the right hand side of the loading curve show that the frictional grip is very nearly of the same magnitude as the bond strength.

In practice, it has been found that the wires in the rope broom, which is about to be socketed, are rarely clean enough to achieve anything approaching a good bond strength. Indeed, it will be shown later, when dealing with uncleaned wires, that the frictional grip alone is enough to seat the cone. Either the bond strength of the resin to the wire or the frictional grip of the resin on the wire, is sufficient on their own to seat the cone. Between them they offer a comforting reassurance that the wire will hold and the cone will seat even if the wire has not been cleaned properly.

The modulus of elasticity was measured and found to be 6085 Mpa (BS63 19 Part 6, 1984).

It very soon became apparent, that the bonding action between the socketing medium and the wire was not in itself sufficient to break the rope. Therefore the focus was moved to the shape of the socket, the wedging action it would produce and the mechanism by which this occurred.

The usual total included angle in sockets is between 14/15 degrees and experiments were carried out over the range 9/25 degrees total included angle. It was predicted that the narrower the angle, the lower the load at which movement occurred and the greater that movement would be. In general, this prediction was confirmed, although in the case of the lower angles, the straight line relationship experienced on the wider angles was not found. See Figure II In all cases, the rope ultimately broke, this confirms that the system will cope with a fairly wide deviation from standard socket dimensions.

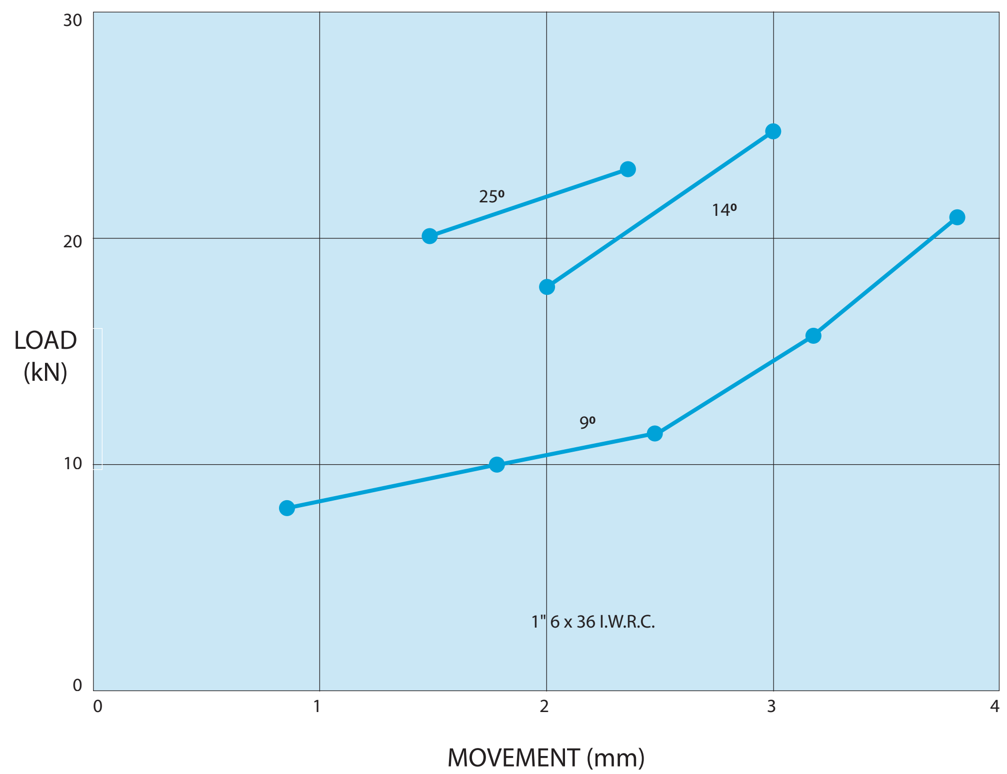


Fig II
Movement within the socket under load for the two extreme angles and the standard 14º taper

the temperature at which the **WIRELOCK®** has been stored for the last 24 hours. when the sockets, rope and **WIRELOCK®** are stored at normal room temperature 18°C - 21°C (65°F - 70°F), booster packs must not be used even if the ambient temperature is below 9°C (48°F). If the temperature is above 35°C the **WIRELOCK®** kit should be refrigerated for two hours before use.

6.4 It is possible to combine various kit sizes to achieve any required volume, e.g. 2500cc = 1 x 1000cc plus 3 x 500cc, etc. In this case, all of the liquid resin should be placed in the mixing container and then all of the powder added to it (or vice versa) before mixing. **Always mix all of the resin with all of the powder. Never mix less than the total contents of all cans.**

Some kits can be mixed in the original packaging (Fig 6)

6.5 Only the 100cc, 250cc & 500cc can be mixed in the original packaging by pouring the resin into the granular materials container. In the case of other kits, a proper mixing vessel should be used (Fig 6).

Mixing vessels should be clean. They can be of metal, polythene or polypropylene. Polymerization products of styrene, i.e. styrofoam cups and similar products should not be used. A flat wooden or metal paddle, not a spike or screwdriver, should be used as a stirrer.

6.6 Immediately upon pouring the resin into the granular compound (or vice versa), mix vigorously for two (2) minutes or until a homogenous mixture has been obtained. Make sure that no unmixed granular compound remains on the bottom of the mixing container. For larger sizes, a mechanical mixer is ideal.

Upon mixing, the WIRELOCK® will turn to a greenish / turquoise colour. If the mix remains a pale straw yellow colour, do not use the kit. Always mix all of the resin with all of the powder. Never mix less than the total contents of both cans.

7 Use of Heat

7.1 Do not apply heat to sockets to accelerate the curing process prior to pouring. The application of external heat may cause the resin to gel before it reaches the bottom of the socket and lead to assembly failure. Used sockets cleaned out by heating (see appendix C) should be allowed to cool to room temperature before re-use.
Hot sockets must not be used.

8 Pouring

8.1 Once the **WIRELOCK®** is mixed, it should be poured immediately (Fig 7) into the socket to ensure good penetration, preferably down the side of the socket to allow air to escape.

Upon mixing the compound should be poured immediately (Fig 7)

Immediate pouring will ensure that the gelling stage occurs in the socket and not in the mixing container. Sufficient **WIRELOCK®** should be mixed so that the socket can be completely filled at one pouring. **WIRELOCK®** is designed to gel in approximately 20 minutes and to cure within 60 minutes after gel. To provide an adequate safety margin, no load should be applied to the wire rope assembly until a minimum of one (1) hour has elapsed from the time the **WIRELOCK®** gels in the socket. As the **WIRELOCK®** cures, a chemical (exothermic) reaction occurs, causing a considerable rise in temperature.

Temperatures in excess of 100°C (212°F) may be reached in large volume kits in the mixing container. In the socket where the wires of the rope and the socket itself act as a heat sink, the maximum temperature likely to be achieved will be in the order of 70°C - 80°C (160°F - 175°F)

9 Movement

9.1 Movement of resin poured sockets may damage the soft resin and reduce the efficiency of the termination. Resin poured sockets should not be moved for a minimum of ten (10) minutes after the material **in the socket** has gelled.

10 Check on Penetration

10.1 A visual check for penetration of the resin into the socket bottom can be made by removing the centralizing clamp and the plasticine or putty. Seizing on the rope adjacent to the neck of the socket should be removed up to the point where it enters the socket.

11 Re-Lubrication

11.1 After removing the rope from the vice, any degreased area of the rope below the socket should be re-lubricated.

12 Loading

12.1 The rope can be put into service or proof loaded one (1) hour after the material in the socket has gelled.

12.2 Whenever possible, the assembly should be proof loaded.

13 Re-use of Socket

13.1 To remove the resin from the socket:

a. Cut the rope close to the base of the socket.

b. Press the cone out of the socket or,

c. Using a gas torch, heat the exterior of the socket. Keep the torch moving around the outside of the socket to avoid any hotspots. Heat the socket until there are fumes coming from the neck of the socket and the top (wide end). when this occurs stop heating, leave for 3 to 4 minutes and then knock the cone out of the socket.

d. It is recommended that sockets subjected to heat should be normalised before re-use.

13.2 For additional information on Re-use of sockets, See Appendix C "Technical Bulletin #1, by Crosby Group Inc. (Page 25)

Appendix B
Resin Socketing of Steel Wire Rope

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The concept is not new. The first published data on this topic were produced in the early sixties. In essence, these two papers by Doherty and Campbell, stated that a resin filled socket under either static tension (tensile) or fluctuating tension (fatigue) could offer strengths that were comparable with those of the rope itself.

There is a dearth of information on socketing and the mechanisms by which it works, so it was necessary to establish some basic knowledge before a resin socketing system could be designed.

In theory, the requirements for a successful system are:-

1) High bond strength between resin and wire
2) High modulus of elasticity

To ascertain the bond strength and the magnitude of the predicted frictional grip, tests were done on a single, straight wire cast into a cylindrical block of resin. The embedded length being such, that the wire when loaded would slip rather than break. The cylindrical resin termination was chosen so that there would be no distortion of the figures, due to the mechanical lock, inherent in a conical termination. The results are shown in Figure 1.

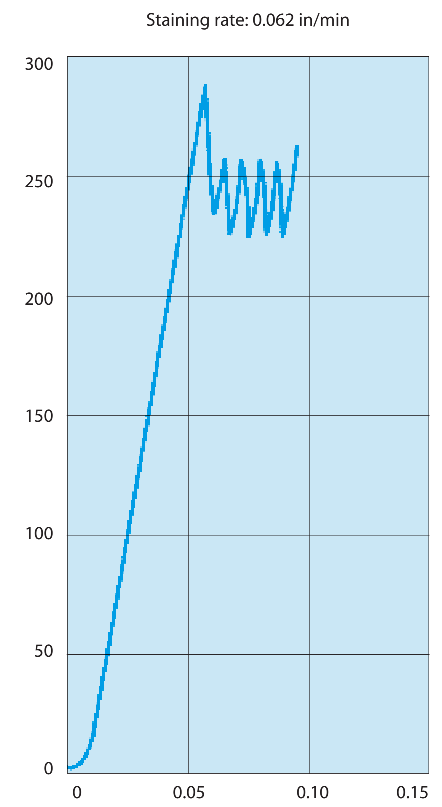


Fig 1

Pull out characteristic for single wire embedded in polyester resin/silica

15. REGULATORY INFORMATION

This product is classified and labelled for supply in accordance with the provisions of the Chemicals (Hazard Information and Packaging for Supply) Regulations 1994 as amended.

EC Label

Flammable

Harmful

Contains Styrene

R10 Flammable

R20 Harmful by inhalation

R36/38 Irritating to eyes and skin

S23 Do not breathe vapour

The provisions of the Health & Safety at Work etc. Act 1974 and the Control of Substances Hazardous to Health Regulations apply to the use of this product at work.

Provision of this sheet does not constitute an assessment of workplace risk as required by other health & safety legislation.

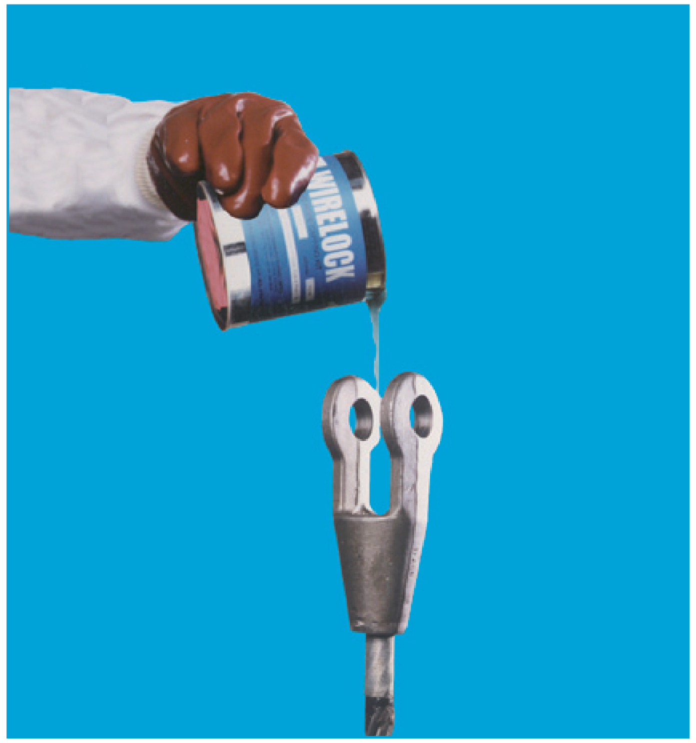
16. OTHER INFORMATION

The information given in this safety data sheet is based on current knowledge. However, should the company become aware of any additional information which is considered to be of relevance then a replacement sheet, incorporating the necessary amendments will be issued.

If this material is further distributed then this health and safety information should be passed to all users of the material.

DATE OF ISSUE: March 2010

General Information



1 **WIRELOCK®** is designed to gel (Change from a liquid to a solid) in approximately 20 minutes at 18°C (65°F). To ensure the kits are not adversely affected by storage they should be kept in a dry place at a temperature of between 10°C and 24°C (50°F and 75°F) and away from any source of direct heat. **WIRELOCK®**, like all polyester resins, is temperature sensitive. An increase in temperature of 10°C (15°F) shortens the gel time by approximately 50%. A decrease in temperature of 10°C (15°F) lengthens the gel time by approximately 100%.

2. KIT SIZES

100 cc

250 cc

500 cc

1000 cc

2000 cc

3000 cc

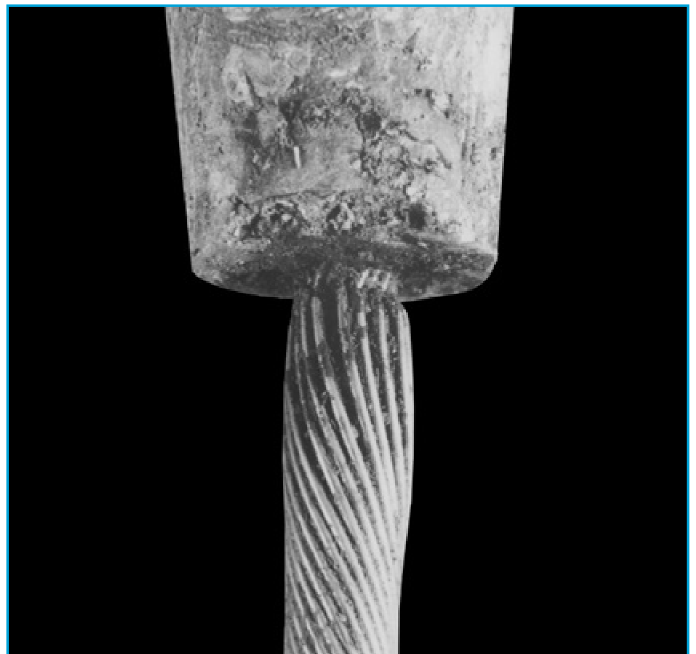
Other sizes available to order

The specific gravity of **WIRELOCK®** is 1.73 Therefore, 1000cc's will weigh 1.73 kilos or 3.81 lbs. 250 cc's will weigh

$\frac{1.73 \times 250}{1000}$ = **0.43 kilos or 0.95 lbs.**

3. **WIRELOCK®** Wire Rope Assemblies are 100% efficient when used with steel wire rope, galvanised wire ropes and stainless steel wire ropes. We do not advise the use of stainless steel wire rope in a salt water marine environment without regular inspection. In the presence of an electrolyte, i.e. sea water, electrolytic degradation of the stainless steel wire rope can occur. This phenomenon, known as crevice corrosion will impair the integrity of the rope in the region near to the neck of the socket. Crevice corrosion also occurs when white metal is used for socketing (Zinc should not be used to socket stainless steel rope). However the onset of crevice corrosion in resin sockets appears to be faster than when white metal is used. Other rope types do not exhibit this behaviour. See illustration.

4. **WIRELOCK®** is approximately 20% the weight of zinc.



typical example of the swelling of stainless steel rope due to crevice corrosion

5. The strength of **WIRELOCK®**, in its cured state, is not adversely affected by cold temperatures.

6. **WIRELOCK®** must be mixed and poured (see 6.3) within the temperature range of -3°C to 35°C (27°F - 95°F). The kits are not adversely affected by storage at temperatures below -3°C (27°F). It is recommended the **WIRELOCK®** kit be stored in a cool place.

7. The operating temperature of **WIRELOCK®** is +115°C to -54°C (+240°F to - 65°F).

8. When cured, **WIRELOCK®** has a hardness of approximately 40 to 50 Barcol. When the resin has set fully (opaque green or mustard colour) only a slight scratch mark will be seen when a sharp object, such as a screwdriver blade, is scraped over the surface of the resin. On a small socket, it is quite normal to have a very thin tacky layer on the surface of the resin. The scratch test can be carried out through this layer.

9. Cracks which may appear on the top of the cured cone are surface crazing only, and are a result of heat stresses and shrinkage upon a thin layer of unfilled resin covering the tops of the wires. The crazing does not affect the strength of the termination within the socket.

10. Shrinkage of the **WIRELOCK®** cone may leave a gap between the cone and the socket wall. This is normal, particularly with large sockets and high ambient temperatures. This in no way affects the efficiency of the assembly. Upon loading, the cone will be seated perfectly in the socket. The shrinkage of **WIRELOCK®** is between 1.5 - 2.0%. In high volume **WIRELOCK®**, the shrinkage is about 0.5%.

11. Excessive numbers of horizontal rings in the socket may increase the load required to "seat" and wedge the cone within the socket. They should be avoided whenever possible and a proof load applied (not exceeding 60% of MBL) if they must be used. Alternatively they should be filled in with clay, prior to placing the socket on the rope.

12. **WIRELOCK®** poured sockets should not be used in environments of strong caustic or acid solutions. **WIRELOCK®** is not affected by oils, or grease or salt water.

13. **WIRELOCK®** is, by design, a compressive resin. Therefore, when removed from the socket a **WIRELOCK®** cone, if hit by a hammer, may shatter. In a socket, even under extreme loads or shockloads, the **WIRELOCK®** cone remains solid and 100% efficient.

14. The shelf life of **WIRELOCK®** is eighteen (18) months (check label before use) from the date of manufacture.

11. TOXICOLOGICAL INFORMATION

Scientific Data:	This product has not been tested for toxicity but due to the styrene content it is classified as "Harmful" and the toxicological properties given below are those of styrene.
Eye Contact:	The vapour is irritating and splashes of liquid will cause discomfort and possible damage.
Skin Contact:	Prolonged contact will have a defatting effect which may lead to irritation and possible dermatitis.
Inhalation:	Over-exposure to vapours may cause irritation to the respiratory system. Excessive concentrations may produce effects on the central nervous system such as drowsiness, leading to loss of consciousness in extreme cases.

12. ECOLOGICAL INFORMATION

Assessment	Evidence suggests it is unlikely that this material will present a serious environmental hazard.

13. DISPOSAL CONSIDERATIONS

Statutory Provisions:	Synthetic resins are subject to the provision of the Environment Protection Act 1990, the Environment Act 1995 and legislation made thereunder such as the Special Waste Regulations 1996. Disposal should be in accordance with these and any regulations in force.
Disposal:	Advice concerning disposal should be sought from the Local Authority, but as a guide, liquid residues should be sent for incineration and spillage absorbed onto inert materials such as sand should be landfilled. Receptacles containing residues present a potential fire and explosion hazard.
Empty Containers:	Non-returnable empty drums should be sent to authorised operators for reconditioning or scrap.

14. TRANSPORT INFORMATION

UK Road/Rail		
Classification:	Flammable Liquid	SI Number: 3269
Packaging Group:	III	
IMO		
Class:	3.3	Packaging Group: III
IMDG Page:	3377-1	UN Number: 3269
AIR		
ICAO/IATA Class:	3	
Packaging Group Air:	III	

WIRELOCK®

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Special protective measures:

Hand:	Solvent resistant rubber or plastic gloves.
Eye:	Goggles conforming to BS 2092.
Skin:	Apron if risk of splashing onto clothing, and boots.

Occupational Exposure Limits

Substance	8hr. TWA (1)		10 min STEL (2)		Comments
	ppm	mg/m(3)	ppm	mg/m(3)	
Styrene	100	420	250	1050	MEL (3)

Notes:

(1) Long term exposure limit, 8 hour time weighted average reference period

(2) Short term exposure limit, 10 minute reference period

(3) Maximum exposure limit

These exposure limits should not be exceeded. For further information on occupational exposure limits see Guidance Note EH40 published by the Health & Safety Executive Also see Guidance Note EH42 “Monitoring strategies for toxic substances”.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance:	Pale coloured liquid.
Odour:	Characteristic
Flash Point:	31ºC approx. (closed cap)
Solubility:	Insoluble in water. Soluble in organic solvents.

10. STABILITY AND REACTIVITY

Stability: The product is supplied with the addition of inhibitors to prevent premature polymerisation, provided the recommended storage conditions are adhered to. (See section 7).

Reactivity: The product is designed to polymerise under controlled conditions upon the addition of recommended catalysts and accelerators. Uncontrolled exothermic polymerisation can occur under certain circumstances. In sealed containers, this could result in build-up of pressure and risk of subsequent explosion and fire.

Conditions/Materials to avoid: Avoid contact with oxidising agents, amines, acids and metal salts as these can promote polymerisation. Prevent exposure to UV radiation, e.g. from fluorescent tubes, as this may initiate slow polymerisation which can continue in re-sealed containers. The product must not be stored at temperatures exceeding 20ºC as this could also cause polymerisation.

Approvals

- ✓ Lloyds Register of Shipping
- ✓ Det Norske Veritas
- ✓ American Bureau of Shipping
- ✓ United States Coast Guard
- ✓ Registro Italiano Navale
- ✓ Germanischer Lloyd

NATO Numbers

100cc	8030-21-902-1823
250cc	8030-21-902-1824
500cc	8030-21-902-1825
1,000cc	8030-21-902-1826

Manufactured by:

MILLFIELD ENTERPRISES (MANUFACTURING) LIMITED

Shelley Road, Newburn Industrial Estate,

Newburn, Newcastle upon Tyne,

NE15 9RT, United Kingdom.

Tel: +44 (0) 191 264 8541

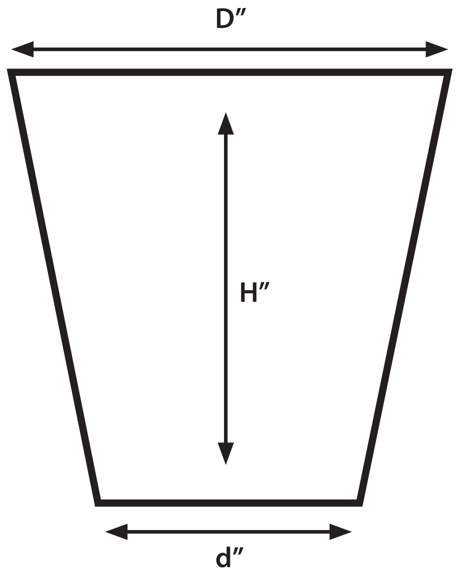
Fax: +44 (0) 191 264 6962

Email: info@wirelock.com

Web: www.wirelock.com

WIRELOCK®

Formula to estimate cc's required to pour standard spelter sockets



$$\left(\frac{D+d}{4}\right)^2 \times H \times 3.142 = cc$$

(D, d & H are in cm)

GUIDE TO AMOUNT OF WIREOCK® REQUIRED

6.5mm (¼")	9cc
8mm (5⁄16")	17cc
9.5mm (⅜")	17cc
11mm (7⁄16")	35cc
12.5mm (½")	35cc
14mm (9⁄16")	52cc
16mm (⅝")	52cc
19mm (¾")	86cc
22mm (⅞")	125cc
25mm (1")	160cc
28.5mm (1⅛")	210cc
32mm (1¼")	350cc
35mm (1⅜")	350cc
38mm (1½")	420cc
41mm (1⅝")	495cc
44.5mm (1¾")	700cc
47.5mm (1⅞")	700cc
51mm (2")	1265cc
54mm (2⅛")	1265cc
57mm (2¼")	1410cc
60mm (2⅜")	1410cc
63.5mm (2½")	1830cc
66.5mm (2⅝")	1830cc
70mm (2¾")	2250cc
76mm (3")	3160cc
82.5mm (3¼")	3795cc
89mm (3½")	4920cc
95mm (3¾")	5980cc
101.5mm (4")	7730cc

NOTE - APPROXIMATE MEASUREMENTS (U.S.A.)

250cc Kit	1 Cup
500cc Kit	1 Pint
1000cc Kit	1 Quart

5. FIRE FIGHTING MEASURES

Special Fire/ Explosive Hazard:	Vapours from this product may be ignited by naked flames, sparks, heaters, electrical equipment, static discharges, and other sources of ignition. Vapours can form explosive mixtures with air, particularly in empty, uncleaned receptacles. Heating of containers will cause pressure rise with risk of bursting and subsequent explosion. Cool intact containers with water spray.
Products of combustion:	Dense black acrid smoke, containing hazardous products of decomposition.
Extinguishing Media:	Foam or dry powder.
Protective Equipment:	Firefighters and others likely to be exposed to vapours should wear self contained breathing apparatus.

6. ACCIDENTAL RELEASE MEASURES

Personal Protection:	Avoid contact with skin and eyes. Beware of fire risk. Do not smoke. Wear suitable protective equipment including solvent resistant rubber or plastic gloves and goggles.
Environmental Precautions:	Remove all sources of ignition. Ventilate area. Do not allow to enter drains or sewers.
Methods Of Cleaning Up:	Contain and collect spillage with non-combustible absorbent material, e.g. sand. (See section 13).

7. HANDLING AND STORAGE

Precautions For Safe Handling:	Avoid contact with skin, eyes and clothing. Avoid inhalation of vapours. Ensure good general ventilation in the workplace with the addition of local exhaust ventilation as required. Use only in areas from which all sources of ignition have been excluded. Prevent the risk of ignition from static discharge. Avoid accumulation of dry residues, contaminated rags etc. to prevent risk of spontaneous combustion. All resins are capable of burning and can give off flammable vapours.
Conditions Of Storage:	Store in original containers at temperatures not exceeding 20 deg. C, in a well ventilated area away from sunlight and sources of ignition. Storage should be in accordance with the Highly Flammable Liquids and Liquefied Petroleum Gases Regulations 1972.

Material Safety Data Sheet

1 IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND COMPANY

Product Name:	Wirelock/Paralock Rope Capping Kit
Company:	Millfield Enterprises (Manufacturing) Limited 16 Shelley Road Newburn Industrial Estate Newburn Newcastle upon Tyne NI15 9RT
Emergency Contact No:	Tel: + 44 (0) 191 264 8541 Fax: + 44 (0) 191 264 6962

2 COMPOSITION/INFORMATION OF INGREDIENTS

Product Description:	Unsaturated polyester resin, dissolved in styrene containing low levels of inhibitors to prevent premature polymerisation. The solid portion of the kit contains less than 1% of Benzoyl Peroxide and does not have any significant health hazards apart from the fact that, as a powder, it may be irritating to the eyes and respiratory system.

Ingredients:	Styrene	CAS No:	100-42-5
Risk Phases	R10, R20, R36/38	EINECS:	202-851-5
Safety Phases:	S23, S24/25, S26, S36/37/39	Concentration: 32% approx	
Classification/Symbol:	Harmful Xn		

3 HAZARDS IDENTIFICATION

Flammable.	Harmful by inhalation. Irritating to eyes and skin. This product may present a possible environmental hazard.

4. FIRST AID MEASURES

Inhalation:	Remove to fresh air, keep patient warm and at rest. If breathing is irregular or has stopped, administer artificial respiration. Give nothing by mouth.
Eye Contact:	Irrigate copiously with clean, fresh water for at least 10 minutes, holding eyelids apart.
Skin Contact:	Remove contaminated clothing, wash skin thoroughly with soap and water or use a proprietary skin cleanser. Do not use solvents.
Ingestion:	If accidentally swallowed, DO NOT INDUCE VOMITING, keep at rest and obtain medical attention.
General:	In all cases of doubt, or where symptoms persist, seek medical attention.

VAT Registration: GB 476 6190 16. Company Registration Number: 1998189. Directors: J.M. Dodd, J.A. Dodd, J.E. Dodd.
Member of the Millfield Group of Companies

Millfield

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MANUFACTURERS OF WIRELOCK AND PARALOCK ROPE CAPPING COMPOUNDS

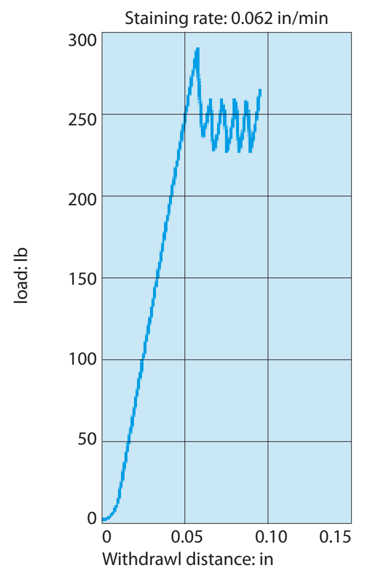
WIRELOCK®

Properties of Wirelock®

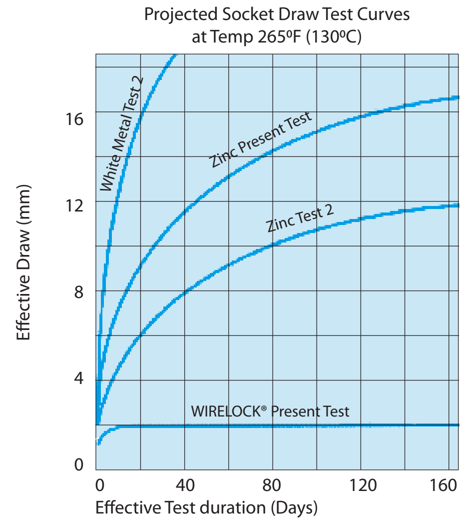
Physical	
Viscosity	3 - 4 Poise
Heat Distortion Point	100ºC to 115ºC (212ºF to 240ºF)
Flexural Strength	1500 lb/sq. in.
Flexural Modulus	5.8 x 10^5 lb. sq. in.
Tensile Strength	16.15 N/mm² 1.09 T/in²
Flashpoint	31ºC (89ºF)
Electrical	
Dielectric Strength	230 volts/mm
Arc Resistance	191 S
Volume Resistivity Greater than	14.5 $\log_{10}$ ohms/cm
Surface Resistance	14.0 $\log_{10}$ ohms/cm
Insulation Resistance	8.2 x 10^{12} $\log_{10}$ ohms/cm

Flashpoint
Please note that this is not the auto ignition (spontaneous combustion) temperature, but the temperature above which the material will give off a significant amount of vapour.

Graph A



Graph B



The individual wires of the rope are retained by a combination of bonding and frictional forces. The frictional forces are the result of:

- Shrinkage during the curing of the resin.
- Coefficient of friction between the resin and the individual wires.

Additional forces develop due to the wedge action within the socket as the rope is loaded.

As **WIRELOCK**® cures, it shrinks by between 1.5% and 2.5%, (High Volume **WIRELOCK**® by less than 0.5%) and with the introduction of a hard inert filler of specific grain size, a high coefficient of friction is obtained.

WIRELOCK® has excellent penetrating qualities and can flow through the densest wire rope broom, which would impede the flow of zinc.

The **WIRELOCK**® system is designed to have a minimal amount of creep, which ceases once the wedging and frictional forces develop for any given load.

WIRELOCK® excels in its ability to resist the action of fatigue - fatigue in a wire rope assembly is normally prevalent in the rope close to the neck of the socket. **WIRELOCK**® will minimize such problems.

UNIVERSITY OF NEWCASTLE

Department of Civil Engineering
Cassie Building
University of Newcastle
Newcastle upon Tyne NE1 7RU
United Kingdom
Head of Department
Professor B G Clarke

11-Mar-99

Millfield Enterprises
16 Shelley Road
Newcastle upon Tyne 15

Job No 99R007

Test Compressive Strength and Stiffness of Resin

Sample 31436/R1792/T40

The specimens were prepared, cured and sent to us by the client.

Date of test 02/03/99
Ambient conditions during the test 20ºC 60%RH
Testing machine Avery 250kN Compression Testing Machine

Sample	Weight	Height (after grind)	Width	Depth	Density	Compressive Load	Compressive Strength
	g	mm	mm	mm	Mg/m³	kN	MPa
31436/R1792/T40-1	101.3	37.5	39.1	39.6	1.74	180.6	116.7
31436/R1792/T40-3	102.2	37.5	39.1	39.6	1.76	187.8	121.3
31436/R1792/T40-5	102.7	37.5	39.1	39.6	1.77	189.6	122.5
31436/R1792/T40-2	104.0	37.5	39.6	39.6	1.77	203.5	129.8
31436/R1792/T40-4	103.2	37.5	39.6	39.6	1.75	196.7	125.4
31436/R1792/T40-6	103.0	37.5	39.6	39.6	1.75	191.0	121.8
average					1.76		124.1

Sample	Min Stress	Max Stress	Mean Strain	Modulus of Elasticity
	MPa	MPa		N/mm²
31436/R1792/T40-1	0.0	58.3	0.243%	1.20E+04
31436/R1792/T40-3	0.0	60.6	0.263%	1.17E+04
31436/R1792/T40-5	0.0	61.2	0.234%	1.27E+04
average				1.21E+04

Renewed
fr DW
31.3.99

RECEIVED
15 MAR 1999

B. G. Clarke
Professor B G Clarke
Head of Department

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Fax • 0191 222 6502

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United Kingdom
Head of Department
Professor B G Clarke

BGC/AEB

21st September 1995

Millfield Enterprises Ltd.
16 Shelley Road
Newcastle upon Tyne
NE15 9RT

Compression Test of Resin Cubes

40mm nominal cubes were supplied. The specimens were cooled by immersing them in a mixture of dry ice and acetone. The temperature was monitored using a similar control specimen containing a thermistor. A specimen was placed between two platens cooled to -18ºC in a refrigerator. The control specimen was also placed between two similarly cooled platens. The specimens were loaded until failure at a rate of 72kN/min.

Specimen	Height	Length	Width	Weight	Bulk Density	Cooling Temperature	Temperature of failure	Max Load	Failure Stress
	mm	mm	mm	g	Mg/m³	ºC	ºC	kN	N/mm²
1	39.7	39.6	40.0	110.9	1.76	-44	-30	203	128
2	39.3	39.3	39.7	108.7	1.77	-55	-30	215	138
3	39.6	39.5	39.7	107.2	1.73	-60	-30	207	132
4	39.6	39.6	39.6	108.1	1.74	-1	-28	204.5	130
5	39.8	39.6	39.7	109.1	1.74	-73	-36	200	127
6	39.7	39.9	39.7	109.2	1.74	74	-38	207	131

B. G. Clarke
B G Clarke

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Telex - 53654 (UNINEW G)

Millfield

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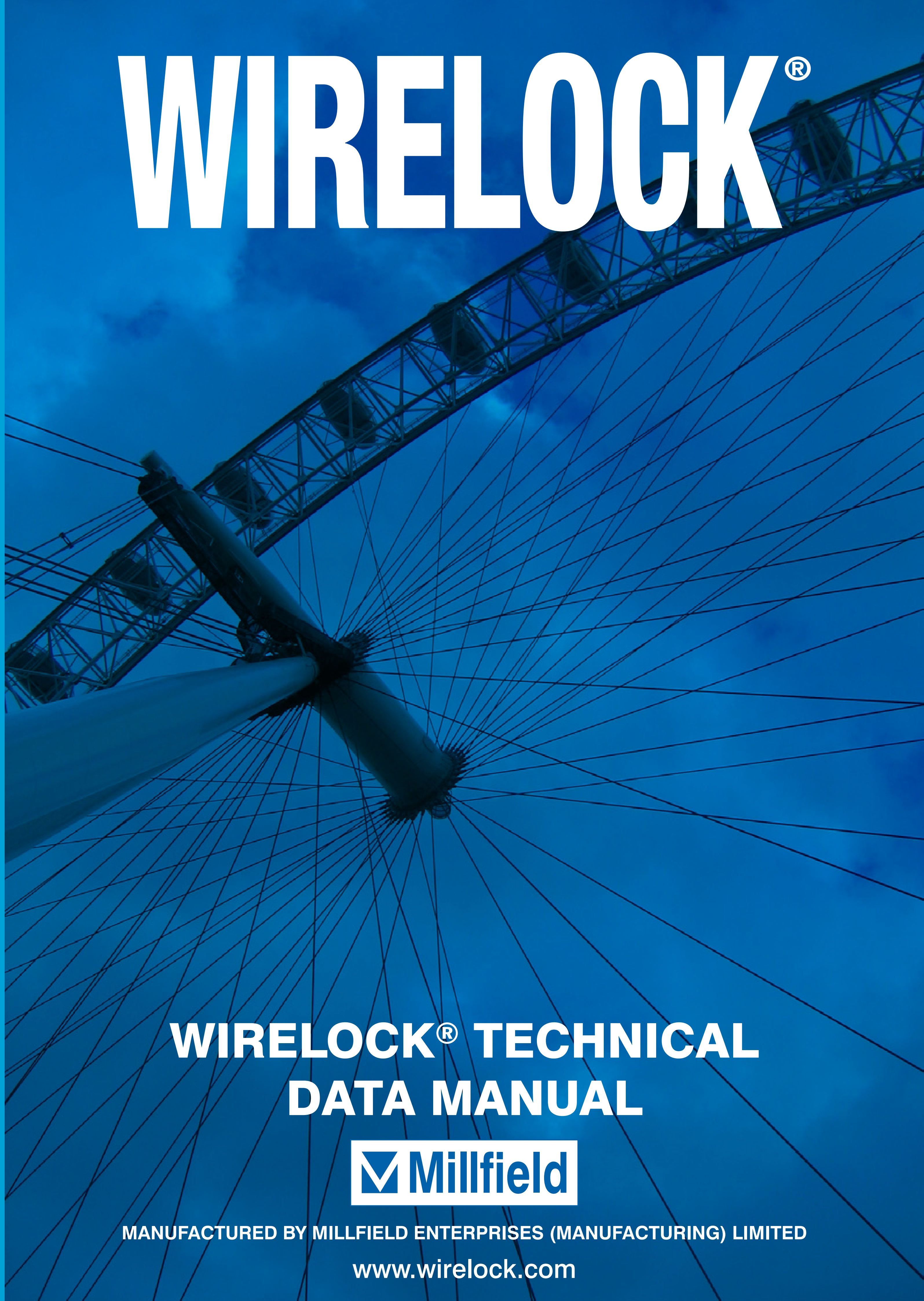

WIRELOCK®

WIRELOCK® TECHNICAL DATA MANUAL

Millfield

MANUFACTURED BY MILLFIELD ENTERPRISES (MANUFACTURING) LIMITED

www.wirelock.com