CHECK-LIST TO AVOID SOLVENT CEMENT WELDS LEAKS

1. PIPE AND FITTING RELATED

(a) LOOSE FITTING COMPONENTS:
Failure of the pipe and or fittings to conform to the dimensional tolerances required by the respective specifications, resulting in a fit that when tested dry is loose enough to provide less than adequate surface contact with the fitting.

(b) TIGHT FITTING COMPONENTS:
Failure of the pipe and or fittings to conform to the dimensional tolerances required by respective specifications, resulting in a fit that when tested dry is so tight as to prevent proper assembly in addition to squeezing out the cement from inside the joint when assembled.

(c) OUT OF ROUND EGG SHAPED COMPONENTS:
Failure of the pipe and or fittings to conform to the out of round requirements of respective specifications, resulting in gaps that cannot be filled by a cement meeting the resin content requirements. Given the very nature of solvent cements, in which the overwhelming portion is subject to evaporation resulting in substantial shrinkage of the cement layer, even a PVC cement with double the minimum amount of resin specified will not possess gap filling properties of any consequence.

(d) EXTRUSION AIDS ON MATING SURFACES (RELEASE AGENTS & LUBRICANTS)
Occasionally, some pipe compounds contain an excessive amount of extrusion aids, such as metallic stearates and waxes, which result in finished pipe where these components are integrated at high levels into the entire matrix of the pipe wall. Similarly, the presence of moulding release agents used to facilitate removal of moulded fittings during manufacture, such as silicone, while not integrated into the plastic matrix of that component, are sometimes found at high concentrations on the fitting surface.
In any event, the result is the presence of materials on the mating surface that are either difficult to remove by conventional cleaners or primers. These slick, waxy chemicals can provide a very effective barrier to the flow together mechanism so essential to the solvent welding process. From time to time one may encounter pipe and or fitting surfaces that are exceptionally hard and consequently very resistant to penetration by the solvents used in cements to soften the mating surfaces. While this phenomenon can be found on any surface, it is most often encountered on the interior surface of the bell section of bell end pipe due to the post heating process by which the bell is formed. This situation may be aggravated when attempting to make welds involving such surfaces in cold temperatures, which inhibit solvent action even on normal surfaces.
Quality cements that fully meet or exceed testing requirements may fail to adequately soften such surfaces; therefore, the industry has recommended the use of primers to aid in the elimination of this problem.

2. WORKMANSHIP RELATED

(a) FAILURE TO TEST PIPE WITH FITTING FOR PROPER FIT
The proper snugness of the pipe and fitting selected is essential to a successful joint. Even using components that are individually within the dimensional tolerances prescribed by respective specifications, it is possible to mismatch an almost oversize socket with a piece of undersize pipe, the result being a very loose match. Conversely, the opposite over tight condition, which causes squeezing out of the cement when assembled, may present itself by selection of an almost oversize pipe section to be used with an undersize fitting.
Even worse, pipe and fittings that are oversize or undersize may, from time to time, be found on the job site. Failure to test for dry fit will eventually result in the use of such mismatched components and consequently cause joint failures.

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(b) FAILURE TO CUT PIPE SQUARE

An un-square cut results in a portion of the socket area not being in physical contact with the pipe surface. This substantially reduces the actual area of joined components in much the same way as failure to insert the pipe fully to the socket depth. A compounding factor in this cause of failure is that the area not in contact is the most critical needed area of the joint.

(c) FAILURE TO REMOVE BURRS OR RAISED EDGES

The burrs created from the sawing of plastic pipe if not removed, can as the pipe is inserted, plough small grooves in the interface of the joining area. Such grooves can be the source of leaks. Alternately, the raised leading edge created by cutting plastic pipe with conventional pipe cutters, if not removed will have the effect of forcing the cement out in front of it as the pipe is inserted into the fitting. This results in a less than adequate amount of cement left inside the joint to melt and join the surfaces.

(d) FAILURE TO CLEAN SURFACES AND REMOVE FOREIGN MATERIALS

In manufacture, handling, storage, and transportation of the pipe, and to a lesser degree, the fittings, a concentration of foreign material that may inhibit the solvent action and or the flow together action of the joined surfaces may accumulate on the area to be solvent welded. This may vary in character from diesel exhaust residue on the pipe acquired during transportation, to atmospheric residues acquired during outside storage, or simply grease and oil from the hands of the assembler or his helpers. Also, there are often some residual extrusion aids waxy in character, and in the case of fittings some residual moulds release agents slippery in character, not removed by the manufacturer. If not removed, these surface contaminants provide a serious jeopardy to the making of a successful joint.

(e) FAILURE TO USE PRIMER

The function of primer is to pre-soften the mating surfaces of the pipe and fitting. Thus allowing the surfaces to be easily softened by the solvents in the cements. While in most cases the nature of the mating surfaces is such that the cement will provide an adequate weld by itself, conditions may exist that would require the use of a primer for adequate penetration. These include, but are not limited to, randomly encountering very hard pipe and fittings surfaces, along with cold weather cementing. Because these conditions are randomly encountered and are neither easily detected nor predicted, and because a primer will always help and won't hurt, the use of a primer, especially on pressure systems is recommended. Remember, most codes call for the use of an approved primer during pressure installation. Always check with code authorities prior to eliminating the use of primer or other recommended procedures.

(f) **FAILURE TO ASSEMBLE JOINT WHILE CEMENT IS WET**

The active ingredients of cements evaporate into the air very quickly. It is essential that these solvents be trapped within the assembled joint where they can actively soften the surfaces as a prerequisite to the desired flow together mating of the surfaces. Failure to work quickly enough, especially in the time frame between application of the cement and assembly of the joint, may result in the cement partially drying prior to assembly. This is one of the more common causes of joint failure, especially when working with larger diameter pipe and fittings in hot climates.

(g) FAILURE TO APPLY AN ADEQUATE LAYER OF CEMENT

A layer of cement of adequate proportions to fill any gaps or spaces that may exist between the pipe and fitting is essential to a leak free joint. Failure to apply the cement in a manner consistent with this requirement will result in leaks due to voids or inadequate fusion of the mating surfaces because all components were not in direct physical contact at all joining areas. A study of joint failures suggests; this is perhaps the most common cause of joint failures.

(h) FAILURE TO APPLY CEMENT UNIFORMLY

Lack of uniformity in the cement layer will result in missed spots or areas that have less than the desired amount of cement or primers applied.

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(i) FAILURE TO INSERT PIPE TO FULL SOCKET DEPTH

To benefit by the entire socket area provided and to maximize the bond strength of the joint, the pipe must be inserted to the full depth of the socket. Failure to do so will result in a reduction of total bonded area. More importantly, due to the taper design of the socket, which causes it to be smaller in diameter at the shoulder than at the entrance, the reduction is in the most critical area of the joint.

(j) FAILURE TO INSERT PIPE WITH A TWISTING ACTION

The purpose of the twisting motion or the giving of a 1/4 turn while inserting the pipe into the socket insures the even distribution of the cement should any light or missed spots exist. Additionally, should there be any air bubbles present in the cement layer this will aid in their elimination. While failure to use, a twisting motion may not be a direct cause of joint failures per se, use of the technique is helpful in eliminating other causes.

(k) FAILURE TO HOLD PIPE IN PLACE AFTER ASSEMBLY

The taper design of the socket operating in conjunction with the pressures formed inside the joint by the swelling action of the cement creates a strong tendency for the pipe to back out of the socket or fitting after assembly. This can and must be prevented by holding the assembly firmly until the cement can set. Failure to do so will result not only in a loss of total bonded area, but also a reduction in the most critical area of bonding surface. In addition, and just as important, backing out takes place as the cement is beginning to set, and movement at this stage can destroy any bonding and could cause joint failure.

(l) ROUGH HANDLING OF FRESHLY CEMENTED JOINTS

Rough handling of an assembly that contains freshly cemented joints may result in enough movement at the interface of the mating surfaces to destroy the bond permanently. Rotation of only a few degrees of the socket on the pipe or any rough handling that results in a disruption of the cement resulting in a poor bond. A loose-fitting socket, and especially one that is assembled during cold weather, is slower to set and consequently more subject to the harmful effects of rough handling.

(m) USING CEMENT FROM A CAN LEFT OPEN FOR A PROLONGED PERIOD

The active ingredients of any cement are very volatile and are subject to rapid evaporation into the atmosphere. A cement container left open when not in use, especially during hot weather, can lose enough of these key ingredients to cause a complete imbalance of the formulated solvent blends. This would result in a cement that lacks the power to soften the pipe or fittings. A performance test should be applied to any questionable cement prior to application.

(n) PRESSURE TESTING BEFORE CEMENT HAS ADEQUATELY CURED

The application of pressure to an uncured joint may have the same effects as rough handling of a joint during the early stages of bond strength development. The stresses involved in even low-pressure applications may be significant enough to cause the slight movement required to disrupt the welding process.

(o) SELECTING THE WRONG CEMENT

Cements are produced in a variety of grades to tailor them for specific applications. Some contain a higher level of plastic than others and or slow evaporating solvents in the blends. These types of cements are designed for use on larger diameter pipe due to the requirement in situations for better gap filling properties and longer working time while the cement is being applied. Because of these differences, the use of cement not designed for an application can result in a failure caused by the cement drying prior to assembly, or less than required gap filling properties. Be safe; follow manufacturer's guidelines for selecting solvent cements.

(p) EXCESS SOLVENT CEMENT

Excess cement will be forced out of the assembled joint as the pipe is inserted. Due to the tapered design of the socket any excess that has been applied to the pipe end will be forced to the outside

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of the assembly where it can and should be wiped off. Any excess applied to the socket will be forced forward by the leading edge of the pipe to the inside of the assembly where it is inaccessible and will lie in a puddle or run down the inside of the pipe. The solvent penetration of the cement may in certain instances eat a hole in the wall of the pipe. This is commonly known as solvent weld pipe burn. This is especially a problem with thin wall pipe class 160 and below and bell end pipe where there is no shoulder provided as in the case of a moulded fitting. In addition, the curve of the pipe where the base of the socket begins on a bell end consists of ordinary wall thickness pipe that has been stretched to form the bell. Stretching results in both a reduced thickness as well as a matrix that has less solvent resistance.

(q) USE OF HOT PIPE OR FITTINGS

When exposed to the sunlight in a hot climate, the pipe surface temperature may reach 48°C to 50°C. Even in cooler temperatures the radiant energy of the sun will raise the exposed surface twenty or more degrees above the ambient conditions. Because application of cement to a hot surface may cause rapid flash off the active ingredients resulting in partially dried cement at the time of assembly, this practice should be avoided. The pipe should be tested for surface temperature and if necessary, cooled down by a suitable method. One method is to wipe the surface with a wet cloth using caution to assure that the water is removed before cementing.

(r) STRESS ON JOINTS

The practice of trying to bend the pipe around a slight curve to make it fit some pre-determined configuration rather than the use of a fitting that would provide the necessary offset, will result in an application of stress to fresh joints. This stress will of course result in a possible failure.

(s) FAILURE TO SNAKE LONG RUNS OF PIPE IN A DITCH

Because of the expansion and contraction characteristics of most plastics, including PVC, long runs of pipe must be placed in a trench in a manner that will allow for contraction without placing undue stress on a freshly bonded joint. The method endorsed by the Plastic Pipe Industry is to snake the pipe in the ditch. Failure to do so may result in complete pullouts or enough disruption of the joint to result in leaks and joint failure.

(t) INEFFECTIVE SOLVENT CEMENTS, CLEANERS, & PRIMERS

Solvent cements are designed, formulated, and manufactured to soften PVC pipe and fittings for solvent welding. If solvent cements adequately soften the PVC surface it will make a successful solvent welded joint. Characteristically solvent cements soften or it will not soften the pipe and fitting surfaces. In other words, if everything is equal during assembly application, and you make ten solvent welded joints, and you have only three that leak, it is most likely not the solvent cement. Some other variables have created the joint failures. That is not to say, solvent cement cannot and will not lose its strength. Evaporation and age are two common causes of strength loss in solvent cements. Solvent cements are formulated with resins, fillers, and aggressive solvents that evaporate very quickly. Each time the container is opened, solvents escape into the atmosphere, as the aggressive solvent evaporates the ratio of solvents to solids become unbalanced. This procedure alters the product viscosity causing it to become stringy, thick, and show signs of gelling. Solvent cements should not be applied when they show any of the altered descriptions above. Scrap test should be performed on any questionable solvent cement, cleaner, and primers before use in any application. These procedures are mentioned and outlined in ASTM D-2855 Standard Specifications for Making Solvent Cemented Joints. Like the pipe and fittings manufacturers' solvent cements and approved primers must meet or exceed ASTM and CSA testing standards.

Solvent cement formulations are tested, approved, and listed by several governing bodies. Products must be within these guidelines each time they are sampled and tested. Manufacturers' in violation or deviating from the original approved formulations could lose their product certification and listing. The test standards and approvals specifications for solvent cements and primers are listed below:

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PVC SOLVENT CEMENTS	ASTM SPECIFICATION D-2564
CPVC SOLVENT CEMENTS	ASTM SPECIFICATION F-493
ABS SOLVENT CEMENTS	ASTM SPECIFICATION D-2235
ABS TO PVC TRANSITION CEMENTS	ASTM SPECIFICATION D-3138
PRIMERS	ASTM SPECIFICATION F-656

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