

INSTRUCTION MANUAL



CS705 Precipitation Adapter

Revision: 4/08



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WARRANTY AND ASSISTANCE

This equipment is warranted by CAMPBELL SCIENTIFIC (CANADA) CORP. ("CSC") to be free from defects in materials and workmanship under normal use and service for **twelve (12) months** from date of shipment unless specified otherwise. ***** **Batteries are not warranted.** ***** CSC's obligation under this warranty is limited to repairing or replacing (at CSC's option) defective products. The customer shall assume all costs of removing, reinstalling, and shipping defective products to CSC. CSC will return such products by surface carrier prepaid. This warranty shall not apply to any CSC products which have been subjected to modification, misuse, neglect, accidents of nature, or shipping damage. This warranty is in lieu of all other warranties, expressed or implied, including warranties of merchantability or fitness for a particular purpose. CSC is not liable for special, indirect, incidental, or consequential damages.

Products may not be returned without prior authorization. To obtain a Return Merchandise Authorization (RMA), contact CAMPBELL SCIENTIFIC (CANADA) CORP., at (780) 454-2505. An RMA number will be issued in order to facilitate Repair Personnel in identifying an instrument upon arrival. Please write this number clearly on the outside of the shipping container. Include description of symptoms and all pertinent details.

CAMPBELL SCIENTIFIC (CANADA) CORP. does not accept collect calls.

Non-warranty products returned for repair should be accompanied by a purchase order to cover repair costs.



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CS705 Table of Contents

PDF viewers note: These page numbers refer to the printed version of this document. Use the Adobe Acrobat® bookmarks tab for links to specific sections.

1. Introduction	1
2. Specifications	2
3. Installation	3
3.1 Siting.....	3
3.2 Mounting Base and Funnel.....	3
4. Datalogger Programming	6
5. Maintenance	6
6. References	7

Appendices

A. MSDS for Campbell Scientific CS705 Antifreeze ..	A-1
B. CS705 Mounting Kit	B-1

Figures

1-1. CS705 Exploded View	2
3-1. Proper Gage Siting	3
3-2. Rain Gage Mount	4
3-3. Pedestal Options	5
5-1. Mix ratio versus precipitation received	7

CS705 Precipitation Adapter

1. Introduction

The CS705 is manufactured by Campbell Scientific and is based on the paper "Measuring Winter Precipitation with an Antifreeze-Based Tipping Bucket System" presented at the 1996 Western Snow Conference (McCaughey and Farnes, 1996). The gage design possesses inherent delays and is not suitable for real time precipitation measurements. Three factors in the CS705 design contribute to the delays in precipitation measurement: air temperature or temperature of the liquid in the reservoir, surface tension in the overflow tube, and precipitation form. A delay of minutes is expected for liquid precipitation—after the gage receives a minimum volume (~0.03” water at 25°C). A delay of several hours (up to tens) is expected for precipitation in the form of snow. Lightest density snow at very cold air temperatures has the longest delay. All precipitation falling into the catch tube eventually flows through the overflow tube and is measured by the tipping bucket gage below.

The CS705 converts the TE525WS tipping bucket rain gage, manufactured by Texas Electronic, into a year round precipitation gage. The CS705 is intended for use during the winter months only. The size of the antifreeze reservoir limits the use of the CS705 to valley locations or regularly visited mountainous locations. Like any sensor, optimum performance is obtained by regular site visits. Any antifreeze-based precipitation gage orifice is susceptible to capping or snow bridging. The CS705 is coated with a smooth black coating to minimize surface adhesion and maximize solar loading. But still, this is no guarantee that snow bridging may still not occur. Please keep this in mind.

The CS705 consists of a catch tube, antifreeze reservoir, and overflow tube (Figure 1-1). Antifreeze is used in the CS705 to convert snow to liquid water. The snow is captured in the catch tube and slowly melts into the antifreeze solution contained in the CS705 antifreeze reservoir. As the snow melts, the level in the antifreeze reservoir rises, this change in level results in a mixture of antifreeze and water flowing through the overflow tube to the funnel of the tipping bucket. A slot in the top of the overflow tube prevents the tube from developing a siphon.

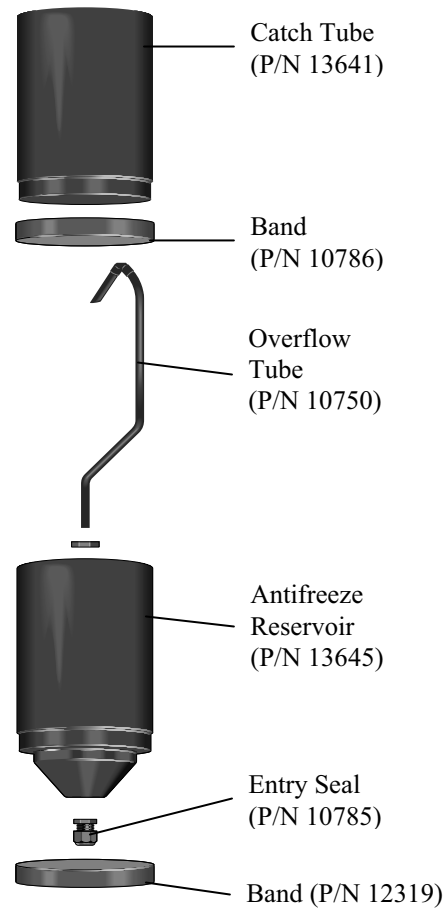


FIGURE 1-1. CS705 Exploded View

2. Specifications

MODEL CS705 PRECIPITATION ADAPTOR

Material:	Black powder coated aluminum
Capacity:	8" of liquid @ -20 ⁰ C operating temperature (assuming 1:0 starting ratio of anti-freeze : water).
Antifreeze Capacity:	~2.5 gallons.
Catch Tube Height:	10"
Catch Tube Orifice:	8.0" diameter
Antifreeze Reservoir Height:	14"
Antifreeze Reservoir Diameter:	8.25"
Total Weight (CS705 + Antifreeze):	~20#s

3. Installation

3.1 Siting

The CS705 precipitation adapter and associated rain gage should be mounted in a relatively level spot which is representative of the surrounding area. The lip of the funnel needs to be horizontal and 30 inches above the ground or higher to prevent burial by snow. The ground cover around the gage should be natural vegetation or gravel. Avoid mounting the gage over concrete or paved surfaces.

The under catch of winter precipitation by antifreeze-based gages is directly related to wind speed. Errors due to wind can be minimized by properly siting your gage. The preferred gage site is in a natural "well protected" location. To ensure proper catch, an angle of 30° to 45° from a vertical line drawn through the center of the gage orifice to the surrounding obstructions should be maintained. Figure 3-1 illustrates the proper siting of a gage.

Gages sited improperly and subjected to high winds will under catch winter precipitation generating erroneous data. An improperly sited gage subjected to high winds can be damaged by the wind.

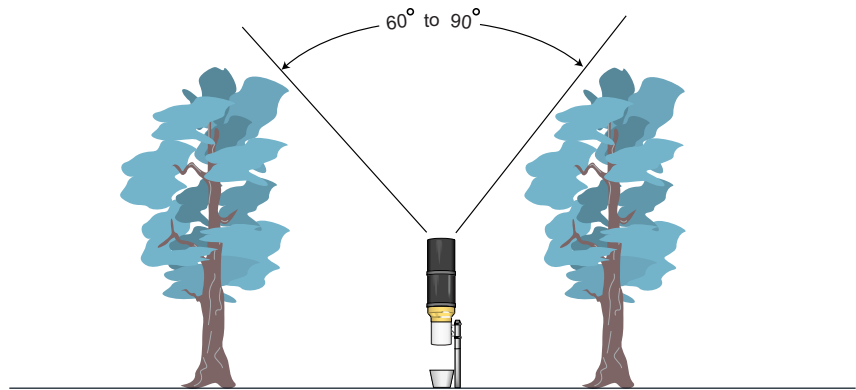


FIGURE 3-1. Proper Gage Siting

3.2 Mounting Base and Funnel

The CS705 is designed to fit inside the funnel of the TE525WS 8" diameter tipping bucket rain gage.

Align the funnel and mounting base to the three holes found on the bottom of the TE525WS rain gage. The funnel is sandwiched between the rain gage and mounting base as shown in Figure 3-2. Three screws mount the funnel to the TE525WS rain gage.

Figure 3-2 shows a mounting option to mount the CS705 precipitation adapter and TE525WS rain gage. The 14087 funnel accepts 1/2" ID hose to drain the precipitation and antifreeze mixture into a suitable container. A band clamp and a u-bolt are used to secure the CS705 to the mounting pole.

You may supply your own mounting pole or purchase one from Campbell Scientific, Inc. Campbell Scientific offers a COM300 series of stainless steel mounting poles. These mounting poles can be used to mount the CS705 away from the tripod or tower.

There is also a pedestal base option for mounting the CS705. There is a pedestal with J-bolt kit, short legs, and long legs. Refer to Figure 3-3 showing the different pedestal options.

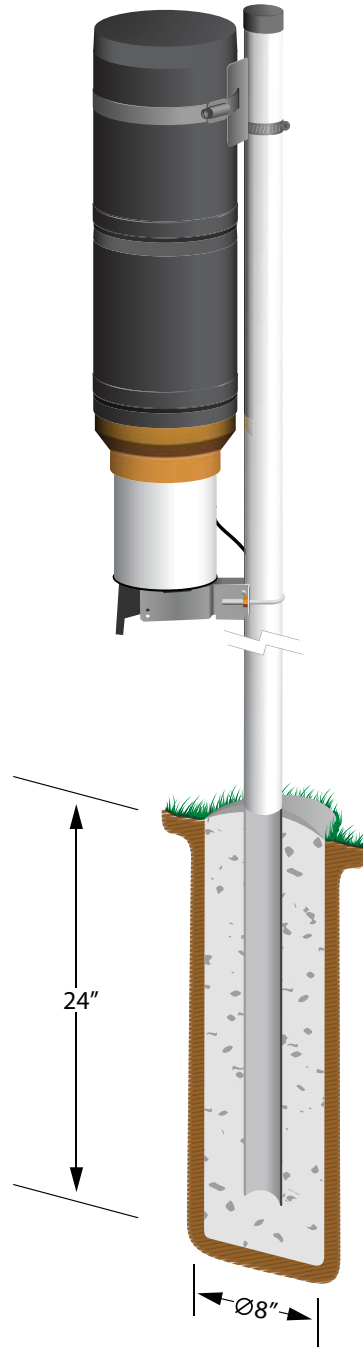


FIGURE 3-2. Rain Gage Mount

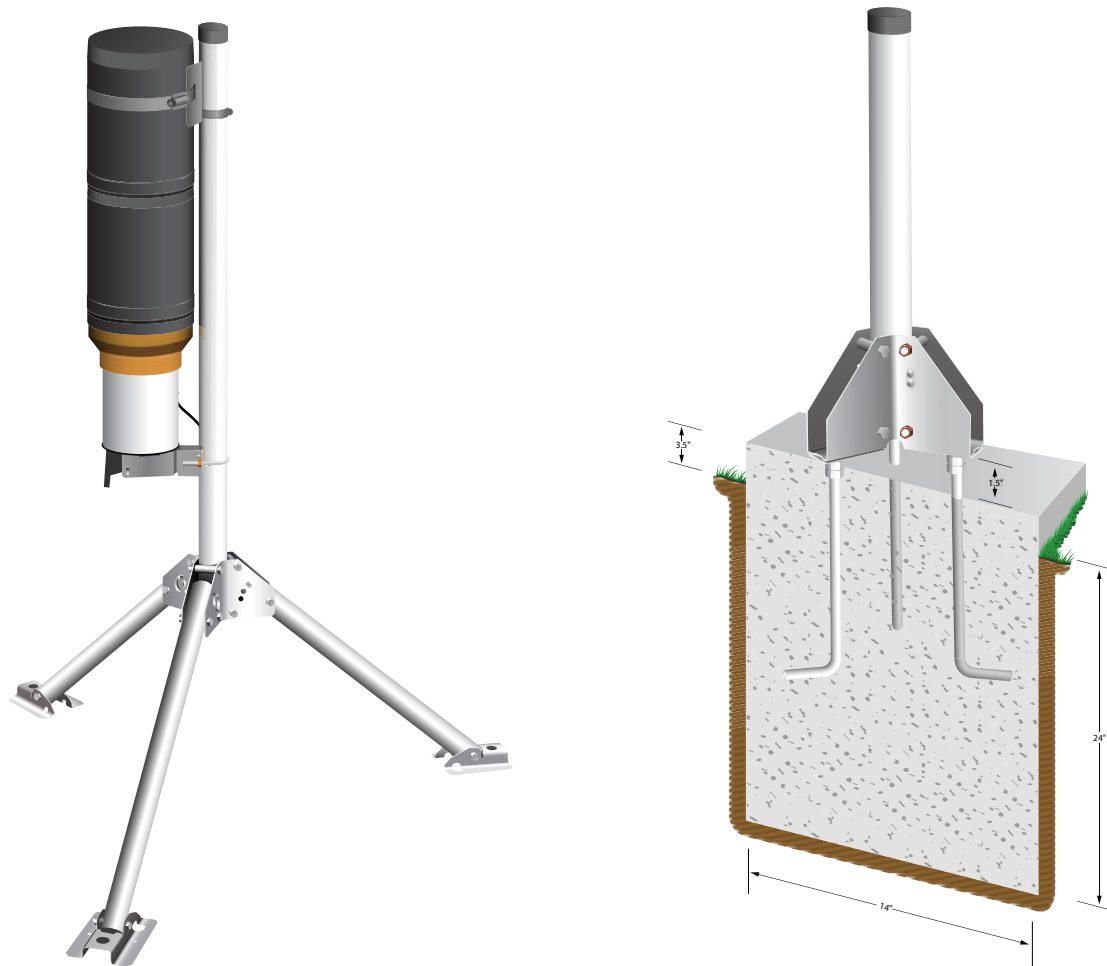


FIGURE 3-3. Pedestal Options

The CS705 is installed as follows:

- Take one of the black bands supplied with the CS705 and stretch over the rain gage funnel (8" funnels only).
- Insert the CS705 antifreeze reservoir into the rain gage funnel.

Safety Precaution: Wear safety glasses during handling and pouring of antifreeze.

- Fill reservoir with antifreeze (Campbell Scientific part number 10869**) until a small amount flows out the overflow tube. The reservoir holds ~ 2.5 gallons of antifreeze.
- Add ~ 8 ounces of a low-freezing-point, environmentally-safe oil to the antifreeze reservoir. This oil prevents the antifreeze solution from evaporating. The oil should cover the entire liquid surface. Some unscented baby oils (lightweight mineral oil) work well.
- Stretch the second black band over the lip of the antifreeze reservoir.

- Insert the catch tube into the antifreeze reservoir.
- Reposition the two black bands to cover the joints between the catch tube—antifreeze reservoir and reservoir—rain gage funnel.
- Container should be placed below the rain gage to collect the solution.
- Solution should be disposed of in accordance with local, state, and federal regulations.

** The recommended antifreeze is a 1:1 mixture of propylene glycol : ethanol (PGE). PGE is a less toxic substitute for glycometh (ethylene glycol and methanol), historically used in antifreeze-based precipitation gages.

4. Datalogger Programming

Refer to the manual supplied with your TE525WS rain gage.

5. Maintenance

The CS705 requires minimal maintenance. During site visits, verify the slot in the top of the overflow tube is free from ice or debris and remove any debris from the catch orifice. If the slot in the overflow tube becomes plugged, the overflow tube may create a siphon and draw down the antifreeze level.

The PGE solution becomes more dilute as precipitation is captured and mixed. Initially, the CS705 is charged with a pure antifreeze mixture giving it a 1:0 antifreeze: water ratio. The ratio increases to 1:1 with the equivalent of six inches of liquid, 1:2 with eight inches, and 1:3 with nine inches. The 1:1 solution becomes slushy at a temperature of $\sim -35^{\circ}\text{C}$, the 1:2 solution becomes slushy at $\sim -20^{\circ}\text{C}$, and the 1:3 solution at $\sim -10^{\circ}\text{C}$ (McGurk, 1992). Ratios greater than 1:3 are not recommended. Refer to Figure 5-1 to determine the amount of remaining antifreeze based on precipitation (water equivalent) recorded.

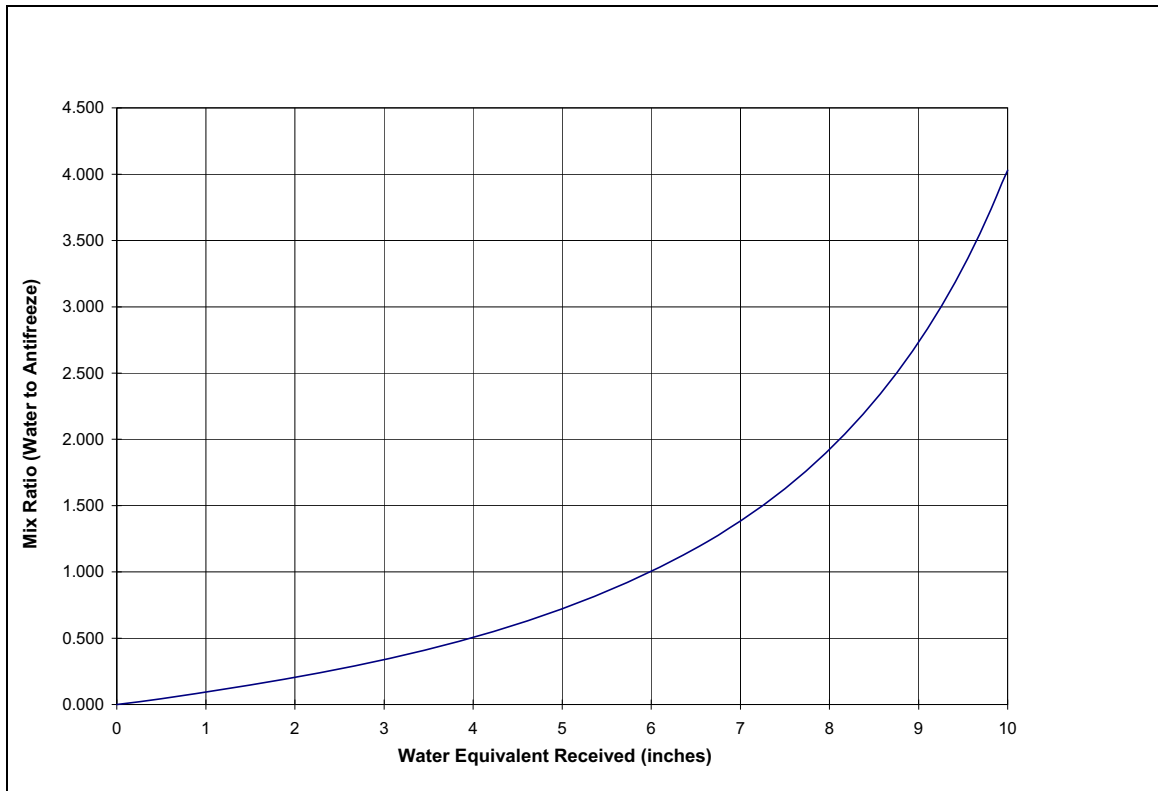


FIGURE 5-1. Mix ratio versus precipitation received.

Tipping bucket rain gages typically are designed to discharge precipitation directly to the surrounding environment. This means the toxicity of any antifreeze solution used in this application needs to be considered. The PGE antifreeze consists of propylene glycol and denatured ethanol. Propylene glycol is a non-toxic biodegradable solution. Commercial ethanol often contains additives to prevent ingestion. These additives result in it being toxic to mammals. Nevertheless, ethanol evaporates rapidly when exposed to air and should pose a limited risk. Individual site requirements will need to be considered though.

When recharging, the solution should be disposed of in accordance with local, state, and federal regulations.

The CS705 is recommended for seasonal use. The CS705 should be removed and cleaned in the summer and replaced before the winter season.

6. References

McCaughey, W. and Farnes, P., 1996. Measuring Winter Precipitation with an Antifreeze-Based Tipping Bucket System. Proceedings 64th Western Snow Conference, Bend, OR. pp. 130-136.

McGurk, B.J., 1992. Propylene Glycol and Ethanol as a Replacement Antifreeze for Precipitation Gauges: Dilution, Disposal, and Safety, in Proceedings 60th Western Snow Conference, Jackson Hole, WY. pp. 56 - 65.

Appendix A. MSDS for Campbell Scientific CS705 Antifreeze

Date Printed: 09-26-1997 Page 1

Interstate Chemical Co.
MSDS for CAMPBELL SCIENTIFIC CS705 ANTIFREEZE

1899--

1 — Site Specific Information

Customer:

2 — Section I - General Information

MANUFACTURER'S NAME: Interstate Chemical Co.

EMERGENCY TELEPHONE NUMBER: (412) 981-3771

CHEMTREC EMERGENCY TELEPHONE NUMBER: (800) 424-9300

ADDRESS (NUMBER, STREET, CITY, STATE, ZIP): 2797 Freedland Rd.
Hermitage, Pa. 16148

CHEMICAL NAME AND SYNONYMS: CAMPBELL SCIENTIFIC CS705 ANTIFREEZE

TRADE NAME AND SYNONYMS: Same as above.

CHEMICAL FAMILY: Solvent blend.

FORMULA: Mixture

DATE OF PREPARATION: 09/26/97

REVISION DATE: N/A

PREPARED BY: Erik S. Bielata, Chemist

ICC MSDS #: IC-00891

DISCLAIMER: All information contained in this data sheet is believed to be true and accurate at this time. However, there is no guarantee expressed or implied. The physical data has been calculated from available information.

3 — Section II - Hazardous Ingredients

COMPONENT:	CAS #:	VOL %	TLV (units)
INTERSOL 84 200 PF.	MIXTURE	<55%	1000 ppm
1, 2 - PROPANEDIOL	57-55-6	<55%	N/A

Interstate Chemical Co.
MSDS for CAMPBELL SCIENTIFIC CS705 ANTIFREEZE

1899--

4 — Section III - Physical Data

BOILING POINT (INDICATE IF "F" OR "C"): 174-212 F

VAPOR PRESSURE (mm Hg): 23 @ R.T.

VAPOR DENSITY (AIR = 1): 2.1

SPECIFIC GRAVITY (H₂O=1): 0.9164

PERCENT VOLATILE BY VOLUME (%): 100%

EVAPORATION RATE (But Ac = 1): 1.7

SOLUBILITY IN WATER: Complete

APPEARANCE AND ODOR: Clear, colorless, liquid; mild odor.

5 — Section IV - HMIS Rating

HEALTH	FLAMMABILITY	REACTIVITY
2	4	0

0 = Minimal 1 = Slight 2 = Moderate 3 = Serious 4 = Severe

6 — Section V - Figure and Explosion Hazard Data

FLASH POINT (METHOD USED): 68 F (TCC)

FLAMMABLE LIMITS: Volume % in Air

LEL: 3.0

UEL: 15.8

EXTINGUISHING MEDIA:

Use water spray, carbon dioxide, dry chemical, or alcohol-type foam applied to manufacturer's recommended techniques.

SPECIAL FIRE FIGHTING PROCEDURES:

Use self-contained breathing apparatus and protective clothing.

Interstate Chemical Co.
MSDS for CAMPBELL SCIENTIFIC CS705 ANTIFREEZE

1899--

6 — Section V - Fire and Explosion Hazard Data (continued)

UNUSUAL FIRE AND EXPLOSION HAZARDS:

Vapors form from this product and may travel or be moved by air currents and ignited by pilot lights or other ignition sources.

7 — Section VI - Health Hazard Data

THRESHOLD LIMIT VALUE: See sect. II.

EFFECTS OF ACUTE OVEREXPOSURE:

EYE CONTACT: Liquid may cause discomfort w/ slight excess redness and possible swelling of the conjunctiva; corneal injury may occur.

SKIN CONTACT: Frequent or prolonged contact may cause discomfort and local redness.

INHALATION: May cause drowsiness, dizziness, disturbances of vision; tingling, numbness, and shooting pains in the hands and forearms.

INGESTION: May cause nausea, abdominal pain, vomiting, headache, dizziness, shortness of breath, weakness, fatigue, leg cramps, confusion, restlessness, visual disturbances, drunken behavior, drowsiness, coma, and death (THERE MAY BE A DELAY OF SEVERAL HOURS BETWEEN SWALLOWING METHANOL AND THE ONSET OF SIGNS OF ANY SYMPTOMS).

- Visual effects include blurred vision, diplopia, changes in color perception, restriction of visual fields, and complete blindness.
- Ingestion of moderate quantities of methanol also produces metabolic acidosis; onset of symptoms may be delayed up to 48 hrs.
- ❖ 60 - 200 mL OF METHANOL IS A FATAL DOSE FOR MOST ADULTS. INGESTION OF AS LITTLE AS 10 mL HAS CAUSED BLINDNESS.
- With massive overdoses, liver, kidney, and heart muscle injuries have been described.

7 — Section VI - Health Hazard Data (continued)

EFFECTS OF REPEATED OVEREXPOSURE:

- Long-term repeated overexposure to methanol vapor concentrations of 3000 ppm or greater may allow a cumulative effect to occur w/ resulting nausea, vomiting, headache, ringing in the ears, insomnia, trembling, unsteady gait, vertigo, clouded double vision.
- Liver and kidney damage may occur, especially when overexposed to ethanol, which may cause liver injury w/ fibrosis.
- Due to its defatting properties, methanol may aggravate an existing skin condition, e.g. eczema; methanol may also aggravate existing liver and kidney diseases.

OTHER HEALTH HAZARDS:

- Repeated ingestion of ethanol by pregnant mothers has been shown to adversely effect the CNS of the fetus, producing a collection of effects which together constitute the fetal alcohol syndrome. Symptoms include mental and physical retardation, learning disorders, motor and language deficiencies, behavioral disorders, and small size head.

EMERGENCY AND FIRST AID PROCEDURES:

EYE CONTACT: Flush eyes with large amounts of water until irritation subsides. If irritation persists, get medical attention.

SKIN CONTACT: Immediately flush with large amounts of water; use soap if available. Remove contaminated clothing, including shoes, after flushing has begun.

INHALATION: Using proper respiratory protection, immediately remove the affected victim to fresh air. Administer artificial respiration if breathing has stopped. Keep at rest, Call for prompt medical attention.

INGESTION: If swallowed, DO NOT induce vomiting. Keep at rest. Get prompt medical attention. Small amounts which accidentally enter the mouth should be rinsed until taste is gone.

Interstate Chemical Co.
MSDS for CAMPBELL SCIENTIFIC CS705 ANTIFREEZE

Date Printed: 09-26-1997 Page 5

1899--

8 — Section VII - Reactivity Data

STABILITY (choose one): () UNSTABLE
(x) STABLE

* CONDITIONS TO AVOID: None.

INCOMPATIBILITY (MATERIALS TO AVOID): Strong oxidizers, strong inorganic acids.

HAZARDOUS DECOMPOSITION PRODUCTS: CO AND CO₂

HAZARDOUS POLYMERIZATION (choose one): () MAY OCCUR
(x) WILL NOT OCCUR

* CONDITIONS TO AVOID: None.

9 — Section VIII - Spill or Leak Procedures

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Contain spill; provide adequate ventilation; keep people away; EXTINGUISH ALL IGNITION SOURCES; keep material out of public waters; use dry absorbent on small spills.

WASTE DISPOSAL METHOD: Dispose of according to all federal, state and local regulations.

10 — Section IX - Special Protection Information

RESPIRATORY PROTECTION (SPECIFY TYPE): NIOSH approved organic vapor cartridge.

VENTILATION:

LOCAL EXHAUST: preferred
MECHANICAL (GENERAL): acceptable
SPECIAL: N/A
OTHER: N/A

PROTECTIVE GLOVES: Rubber or neoprene.

EYE PROTECTION: Safety glasses or goggles.

OTHER PROTECTIVE EQUIPMENT: Rubber apron and boots; eye bath, safety shower.

Interstate Chemical Co.
MSDS for CAMPBELL SCIENTIFIC CS705 ANTIFREEZE

1899--

11 — Section X - Shipping Data

D.O.T. SHIPPING NAME: FLAMMABLE LIQUIDS, N.O.S.
(contains Ethanol)

PRODUCT NAME: CAMPBELL SCIENTIFIC CS705 ANTIFREEZE

D.O.T. HAZARD CLASS: 3

U.N./N.A. NUMBER: UN-1993 (PG II)

PRODUCT RQ: N/A/

D.O.T. LABEL: FLAMMABLE

D.O.T. SUBSIDIARY LABEL: N/A

D.O.T. PLACARD: FLAMMABLE

12 — Section XI - Special Precautions

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING:

***DANGER!!! May cause eye damage and blindness if swallowed.

- FLAMMABLE
- Harmful if inhaled
- Harmful if absorbed through skin
- Causes eye irritation
- May cause drowsiness, dizziness
- May cause heart muscle damage
- May cause liver and kidney damage
- DO NOT SWALLOW
- Keep away from heat, sparks, flame
- Avoid breathing vapor
- DO NOT get on skin, on clothing
- Avoid contact w/ eyes
- Keep container closed
- Use w/ adequate ventilation
- Wash thoroughly after handling

OTHER PRECAUTIONS: FLAMMABLE LIQUID - Clean equipment thoroughly prior to maintenance and/or repair.

PROCESS HAZARD - Sudden release of hot organic chemical vapors or mists from equipment operating at elevated temperature and pressure, or sudden ingress of air into vacuum equipment, may result in ignitions w/ out the presence of obvious ignition sources. ANY USE OF THIS PRODUCT IN ELEVATED-TEMPERATURE PROCESSES SHOULD BE THOROUGHLY EVALUATED TO ESTABLISH AND MAINTAIN SAFE OPERATING CONDITIONS.

Interstate Chemical Co.
MSDS for CAMPBELL SCIENTIFIC CS705 ANTIFREEZE

Date Printed: 09-26-1997 Page 7

1899--

12 — Section XI - Special Precautions (continued)

TRANSFER HAZARD - Vapors of this product may be ignited by static sparks.

13 — Section XII - SARA Title III

This product contains the following toxic chemical that is claimed as a trade secret, but disclosed as an upper bound concentration to comply with the reporting requirements of Section 313 of the Emergency Planning and Community Right-to-Know Act of 1986 and of 40 CFR Part 372.

**METHANOL (CAS #67-56-1) ---- <5%

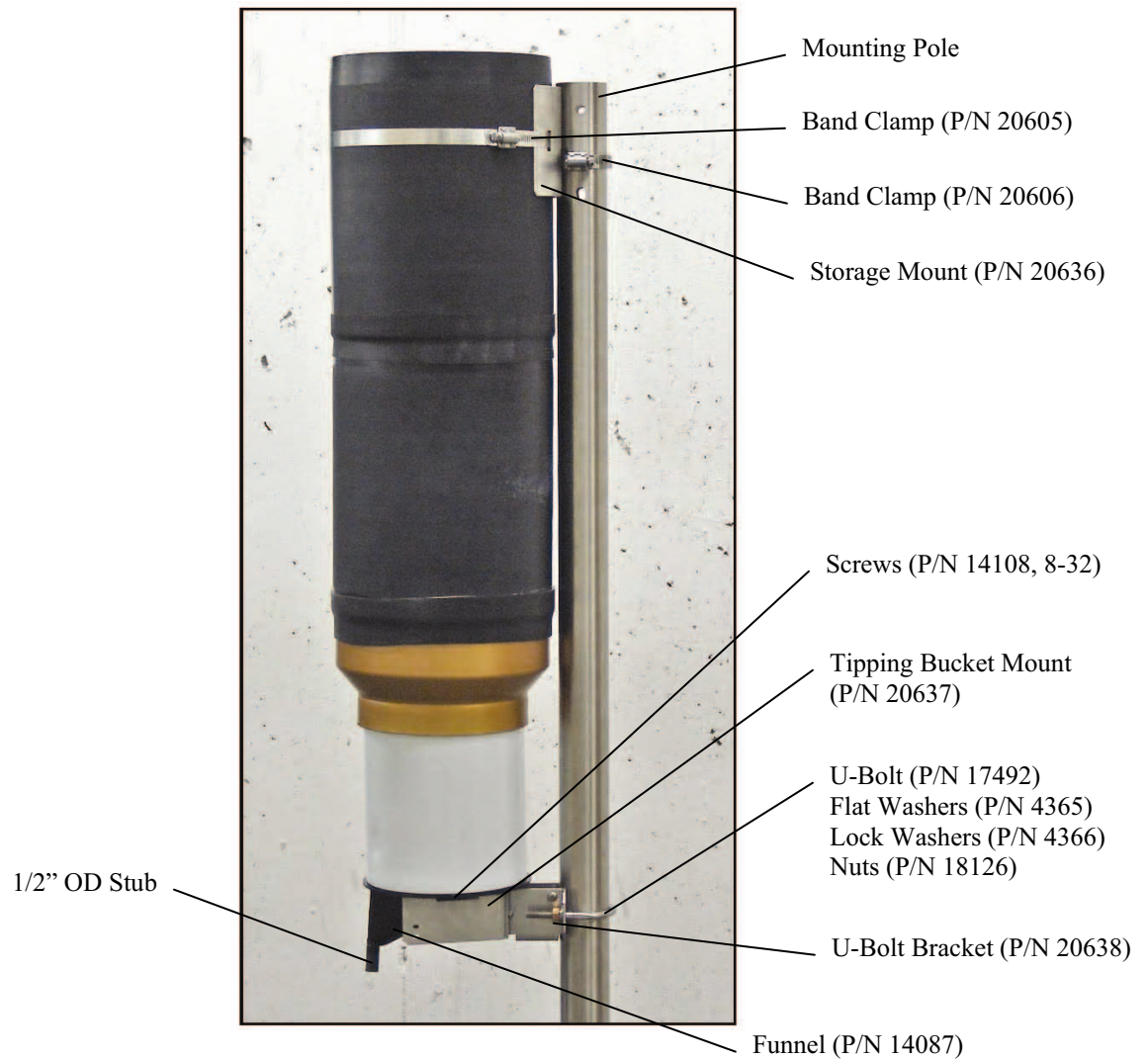
14 — Section XIII - Section Revisions

Revisions have been made to the following sections:

Appendix B. CS705 Mounting Kit

The CS705 has a new funnel and mounting kit CM270, part number 20621. The mounting kit includes a funnel mount for the bottom of the rain gage and mounts to secure the top of the CS705 to the mounting pole.

The CM270 funnel and mounting kit includes:



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