# MAINTENANCE & SAFETY MANUAL



**SSCAFCO**.

# WARNING!

# Read Immediately

Failure to follow the information contained in this bulletin may void structure warranty. Further catastrophic damage may occur to property or human life.

GS3001E

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Note: Whenever mentioned in this manual, the term 'silo' refers to bins and/or silos.



# SCAFCO Grain Systems Company

# Limited Warranty

SCAFCO Grain Systems Company (SCAFCO) warrants the following products to be free from defects in material and workmanship for the period specified in the table, beginning on the date of invoice to the original purchaser. In the event of a product defect within the warranty period, contact a SCAFCO representative for instructions on obtaining warranty service. Upon SCAFCO's verification of a defect under the SCAFCO warranty, SCAFCO will, at its sole option, repair or replace the defective product. Transportation costs in shipping the defective product to the factory or manufacturer (if required), and returning the repaired or replacement product to the original installation site shall be borne by the purchaser.

Products and equipment not listed in the table that SCAFCO acquires from or through a manufacturer, distributor, or other third-party provider and resells to purchaser will carry the original manufacturer's pass through warranty, if any.

Product	Warranty Period
Commercial, farm and hopper bottom grain storage silos	5 years
Aeration systems (including axial and centrifugal fans)	2 years
Catwalks, catwalk supports, and towers	2 years
Drying systems (including perforated planks and corrugated drying floors)	2 years
Ladder systems and roof stairways	2 years
Conveyors and elevators	1 year
SCAFCO manufactured accessories	1 year

### Warranty Conditions

- The product must be purchased from SCAFCO or a SCAFCO authorized dealer, and installed by an authorized SCAFCO dealer or certified representative.
- The product must be installed and operated in accordance with SCAFCO published installation and operating instructions.
- The product must be used only with grains and/or other free flowing materials.
- Standard grain silo design follows. Any other loading condition must be specifically requested (at extra cost) prior to order.

Unstiffened silo design is based on:	Stiffened commercial silo design is based on:	
90 mph Exposure C wind - UBC	90 mph Exposure C wind - UBC	
115 mph Exposure C wind - IBC	115 mph Exposure C wind - IBC	
No seismic	Seismic zone 1 - UBC	
	Seismic design category A - IBC	

Standard storage silos are designed to store dry, freeflowing grain with a density up to 52lb/ft<sup>3</sup> [832kg/m<sup>3</sup>]

- Silo Loading/Unloading Warning: All grain silos, bulk feed tanks, and hopper bottom tanks are designed to be filled and unloaded from the center of the silo or tank. Any other method of filling or unloading can result in structural damage to the bin. Any off-center discharge openings should be used for the sole purpose of silo clean-out after the center discharge has emptied the tank to the grain's natural angle of repose. Failure to limit usage of any off-center discharge opening, including the improper use of side discharge systems, could result in non-warranted structural damage to the silo.
- Roof Damage Warning: SCAFCO grain silos are designed to be filled to within 1" [25mm] of the top of the top ring at the grain's natural
  angle of repose. Filling beyond the top ring, so as to apply grain pressure to the underside of the roof or blockage of roof vents, may
  result in non-warranted structural damage to the roof. Roof damage due to excessive vacuum or internal pressure caused by fans or other
  air moving systems is not warranted. Adequate roof vents must be provided for all air handling and aerations systems. Roof vents must
  not be blocked by grain or freezing over due to operation during humid/cold weather conditions.
- Drying Floors: Grain pressure can and may cause perforated plank drying floors to deform, especially with higher eave heights. This deformation does not reflect a failure and is not warranted by the manufacturer.

### Warranty Exclusions and Limitations

This warranty does not apply to:

- Products installed by anyone other than a SCAFCO authorized dealer or SCAFCO certified representative.
- Products installed with structural components other than those supplied by SCAFCO.
- Product malfunctions, damage, or failure resulting from misuse, abuse, negligence, alteration, accident, misapplication of specifications or lack of proper maintenance.
- Products used in conjunction with anything other than grains and/or other free flowing materials.

**WARNING:** Galvanized materials are subject to unsightly 'white rust' if moisture penetrates the wall sheet bundle. To avoid this condition, separate wall sheets so that air can dry the sheets.

**WARRANTY DISCLAIMER:** SCAFCO shall not be liable, whether in contract, negligence, tort, or on any other basis, for cover or for incidental, consequential, special, or exemplary damages including, but not limited to, loss of sales, profits or orders, lost or damaged products or goods, transportation costs, operational inefficiencies or downtime costs, which the purchaser may suffer, or claim to suffer as a result of a product defect.

THIS WARRANTY CONSTITUTES SCAFCO'S ENTIRE AND SOLE WARRANTY, AND SCAFCO EXPRESSLY DISCLAIMS ANY AND ALL OTHER WARRANTIES, INCLUDING BUT NOT LIMITED TO, EXPRESS AND IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, NON-INFRINGEMENT, OR ANY IMPLIED WARRANTY ARISING FROM COURSE OF PERFORMANCE, COURSE OF DEALING, OR USAGE OF TRADE.

This warranty may only be modified by a written statement signed by an officer of SCAFCO.

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# WARNING to Owners and Contractors

Grain storage silos are structures that are constantly under static and dynamic forces in varying degrees. SCAFCO grain silos and hopper bottom tanks are designed for and manufactured to withstand these forces when properly installed and operated.

Proper assembly and installation of these storage structures will provide many years of service to our customers. To help ensure this, the contractors and owners who plan to install the structure themselves must follow these guidelines:

- The contractor/owner should thoroughly study and follow the installation manuals and drawings supplied with the product.
- The contractor/owner should contact SCAFCO customer service to clarify any possible questions about the instructions or drawings before or during installation work.
- Non-compliance with the instructions shown in the manuals and/or drawings, or unauthorized modification(s) will void the manufacturer's warranty and may result in structural damage/failure, injury, or even death.

# SAFETY FIRST!!!

It is your responsibility as an owner, operator or supervisor to know what hazards exist and to make these known to all other personnel working in the area, so that they may also take any necessary safety precautions that may be required.

# LISTED BELOW ARE SOME IMPORTANT SAFETY ISSUES FOR DEALERS, INSTALLERS, AND SILO OWNERS. NOTE THAT THIS IS NOT AN ALL-INCLUSIVE LIST.

- Before constructing the grain silo and associated equipment, make sure all workers are provided with the necessary safety information and equipment to perform their work in a risk-free manner.
- Be aware and stay clear of any overhead power lines, as the silo or construction equipment could come in contact with power lines and cause electrocution.
- Guards and shields are provided for your protection. Keep them in place and secure. Replace any damaged or missing guards and shields.
- Before performing any service on the silo or associated equipment, make sure that electrical power is off and locked out.
- Never enter a storage silo when grain handling machinery/equipment is in operation. You could be seriously injured or killed if you become tangled in the equipment while it is running or if it is inadvertently turned on.
- Grain silo entrapment accidents can affect people of all ages and experience. Entrapment can happen in a matter of seconds. Prevention, as well as emergency response, will play a critical response in survival.
- Load and unload grain only from the center of the silo and maintain an even level of grain height around the walls of the silo. Failure to follow this procedure may result in structural failure of the silo from unbalanced forces acting on the silo walls.
- Make sure that all personnel working on or around this equipment are made aware of the hazards and are given these safety precautions. Keep children and unauthorized persons away from your grain storage facility.
- Several decals are attached to the equipment at various places to call your attention to its message concerning your personal safety. Read and heed the message and be alert to the possibility of personal injury or fatality. If the decal(s) become damaged or detached, contact your SCAFCO representative or SCAFCO Grain Systems Company for replacement decals.

### FAILURE TO HEED THESE WARNINGS COULD RESULT IN SERIOUS INJURY, DEATH, STRUCTURAL DAMAGE OR COLLAPSE OF TANK.



# **Unloading Instructions**

- 1. Use center gate only until no grain remains above this outlet.
- 2. Intermediate gates to be used only when above condition is satisfied.
- 3. Lock all intermediate gates to avoid accidental premature use.
- 4. See manufacturer's instructions for proper use of factory supplied side draw discharge systems.

# Read and Understand All Equipment Manuals Before Using This Silo

This silo is designed to be filled and emptied only from the center with free flowing material. Any off-center discharge of material from the silo may result in partial or total failure of the silo.

If a side discharge system was supplied with your silo, please read and understand its specific operating procedures and limitations in this manual.

Operation not in accordance with these rules may result in structural damage and loss of the silo contents due to:

- 1. Excessive pressures on the roof.
- 2. Improperly filling or emptying material off center in the silo (side draw, intermediate gates, etc.)
- 3. Access doors improperly latched.
- 4. Improper increase or decrease of moisture content in material stored within the silo.
- 5. Improper and unauthorized alterations of the structure.
- 6. Improper replacement of the components.
- 7. Improper application and use of auxiliary equipment.

FAILURE TO HEED THESE WARNINGS COULD RESULT IN SERIOUS INJURY, DEATH, STRUCTURAL DAMAGE OR COLLAPSE OF TANK.

WARNING



YOU CAN SUFFOCATE UNDER GRAIN IN THIS SILO!



# Do not enter when the silo is being loaded or unloaded.

# If you must enter the silo:

- 1. Shut off and lockout all power.
- 2. Use a safety harness and life line.
- 3. Wear proper breathing equipment or respirator.
- 4. Avoid the center of the silo.
- 5. Station a person to help from outside the silo.

# KEEP CLEAR OF ALL AUGERS



Rotating flighting could kill or dismember



Vertically crusted grain could collapse and suffocate



Horizontally crusted grain could collapse and suffocate



Flowing grain could trap and suffocate

# FAILURE TO HEED THESE WARNINGS COULD RESULT IN DEATH OR SERIOUS INJURY.

# **General Operation Guidelines**

SCAFCO Grain Systems Company strives to incorporate safety in its products, whether during handling, erection, or operation. Safe working conditions, safe working methods, and safe products should always be of prime concern to contractors, erectors, and manufacturers.

Federal safety standards (OSHA) have been established by the U.S. Department of Labor. Employers are obligated to familiarize themselves with the requirements of the standards and put them into practice. Employers should also be aware of all pertinent State and Local codes and other applicable codes or guidelines from OSHA, insurance company, national, and international safety agencies.



Watch for this symbol. It points out important safety precautions. It means "Attention - Be Alert! Your safety is involved."

# **Before Filling Your Silo For The First Time**

Perform a thorough silo inspection before filling for the first time. A detailed checklist can be found on page 25. Promptly addressing a construction flaw can make a difference in the life and usability of the silo.

- All anchor bolts and fasteners are tight.
- Wall sheets, stiffeners, access doors, and all other parts of the silo are properly installed.
- Unloading gates and access doors are closed and work properly.
- Electrical equipment works properly.
- Temperature cables are properly mounted. See temperature cable manual for details.
- Written procedures are in place for filling and discharging silos in accordance with national codes and standards.
- Personnel are trained in proper and safe filling and discharging procedures and practices.

# **Silo Filling Procedures**

Adherence to the following procedures will extend the service life of the silos with a much lower risk of structural damage, economic loss and personnel injury.

Before you begin filling your silo, check that all discharge gates are closed and locked. There are suffocation hazards in flowing grain. Never enter a silo with flowing grain or other material. Keep people out of the silo, except when absolutely necessary.

Silos **must be filled concentrically** through the peak cap. Use of a grain cushion box (dead head) is recommended to direct the grain straight down into the silos so they are concentrically filled.



# Silo Filling Procedures (cont.)

**Commercial stiffened silos must be filled in stages.** Unevenly distributed grain can cause a large amount of distress on silo walls and could result in damage and structural failure over time.



**Stage 1**: Fill bin approximately one third full. Inspect bin and ensure grain filled in a concentric cone.



**Stage 2**: Fill bin to approximately two thirds full. Inspect bin and ensure grain continued to fill in a concentric cone. **Minimum 8 hours wait time before proceeding** to allow for compaction and consolidation.



Stage 3: Fill bin to no more than 1" [25 mm] below eave. Inspect bin and ensure grain continued to fill in a concentric cone. Minimum 24 hours wait time prior to unloading.

If existing grain storage silo conveyor systems are to be modified or replaced with higher capacity equipment, it is wise to check with the system designer and SCAFCO before proceeding with the modification. Serious increases in the filling rate can change the dynamic loads on the silo, causing the silo to experience distress, distortion, or structural failure. SCAFCO is willing to assess the impact of any capacity changes in the filling equipment and provide written recommendations for structural considerations due to proposed changes.



# Beware of Overfilling

Avoid non-warranted roof damage from overfilling. Never fill the silo more than 1" [25 mm] below the eave. Grain higher than that can put pressure on the underside of the roof as well as block air vents and cause roof damage. This can cause an assortment of problems ranging from roof damage to possible structural collapse.



DO NOT OVERFILL ABOVE EAVI

# **Simultaneous Filling and Discharge**



Simultaneous filling and discharge results in the grain behaving more like a fluid than a granular material. An increase in the fluidic behavior of the grain can cause an increase in silo wall sheet hoop tension, especially in tall, small diameter silos. The effect on silo wall loads generally becomes less pronounced as the diameter of the silo increases. The service life of the silo can be drastically reduced and the risk of structural failure, economic loss and personnel injury will increase by simultaneous silo filling and discharge at high rates. Please contact SCAFCO if you have any concern about this type of operation.

# Silo Discharge Procedures



Avoid improper unloading! Grain silo collapses can spill thousands of bushels of grain resulting in significant financial losses. Prevention is of utmost importance when preparing to unload your grain silo. Each time you unload grain you must begin from the center gate. You should never begin unloading grain from an intermediate gate. Doing so could result in serious injury, structural damage, and material losses.

If existing grain silo discharge conveyor systems are modified or replaced with higher capacity equipment, contact SCAFCO for advice about the structural integrity of the silo under these new conditions. Discharging grain at very high capacities alters the dynamic forces on the silo walls for which the original design may not be adequate.



from improper unloading can cause sides to deform.

> When silo sidewalls deform, excess pressure builds. The silo can become structurally unsound and the sides can buckle causing grain spills.



# Silo Discharge Gate Operation Procedures

All silo discharge openings must have gates. Gates other than the center gate should have locks to prevent accidental eccentric discharge of grain from the silo.

Gate operation and use are to be controlled by the owner/manager of the grain facility after receiving instruction by SCAFCO's representative and/or dealer. Gates must be locked so that no one other than the owner/manager can operate them.

Silos must be gravity discharged through the center gate first. During normal grain discharge operations, grain will flow by gravity to the center discharge gate. As discharge nears the final stage, no more grain will flow to the center gate. Then, the next gate adjacent to the center gate may be opened, working from the center outward. If there are gates on both sides of the center gate, systematically work out from the center of the silo on both sides until reaching the outer gates. Any variation in this process may result in eccentric discharge and possible structural failure of the silo.

Make sure gates are fully closed before operating any type of conveyors. Any type of leakage through intermediate gates could result in eccentric discharge of grain from a silo causing severe deflections, distortions, and structural failure of wall sheets and stiffeners.

If the silo center gate becomes plugged, the blockage must be cleared before any other gate is opened. If the blockage cannot be cleared, contact a qualified silo dealer, SCAFCO, or a silo design engineer for assistance. It is generally recommended that methods and procedures for unplugging silo center gates should be well-developed by the dealer and owner prior to filling a silo the first time.

# Silo Discharge Procedures (cont.)

Incorrect





**DON'T** Eccentric discharge at floor or wall. Uneven side pressure causes buckles.



Correct

The silo shall be unloaded from the center discharge gate until all possible grain has been removed by this port.

# Silo Clean-out Procedures

### **Sweep Auger Operation**

The silo should be totally emptied periodically in order to remove compacted grain remaining against the silo walls. A sweep auger can assist in accomplishing this task. Follow the sweep auger manufacturer's instructions for installation and operation.

**CAUTION:** The sweep auger will vary in performance based on material consistency and grain condition. Capacities listed by the sweep auger manufacturer are optimum based on dry, clean, and ideal conditions. The sweeping process will be complete after one or two revolutions. After completion of the sweep process a minimum of 2-3'' (51 mm – 76 mm) will remain for manual sweeping. Although the sweep auger components are warranted against defects in material and workmanship for one year, when installed and operated according to manufacturer's instructions, SCAFCO does NOT warranty sweep auger performance. If the sweep auger is left in silo after clean out, it must be removed from the center gate sweep pivot and laid next to unload system. Left installed in sweep pivot during filling and emptying can result in damage to center gate and/or the sweep auger.

### **Broom Sweeping**

Final clean out of the silo should be performed by broom sweeping the silo floor. This not only provides a clean storage environment, it also allows an opportunity for qualified facility employees to perform a visual inspection of the silo anchorage and the lower silo structure. Early detection of a structural problem saves money and injuries to facility personnel. It is recommended that a qualified silo contractor inspect silos annually and perform maintenance as needed to all silos and equipment.

### **Dust and Fines**

Aeration trench and pad covers should be lifted, inspected and cleaned out annually to minimize insect infestations and avoid blockage restricting aeration airflow.

Care must be taken by silo owners/managers to prevent grain leakage into aeration trenches. Leaks cause accidental grain movement, causing new flow channel development adjacent to silo walls which can cause damage to the silo.

### **Giant Doors**

Inspect connections of the giant door frame to the silo walls monthly. Report any changes in welds, bolts and hinges to the installer/manufacturer immediately. Seal giant doors after filling silos to prevent grain spoilage, rust and moisture accumulation.

# Side Discharge Systems

SCAFCO Side discharge systems allow the user to discharge free-flowing grain from the side of a silo to load trucks or other conveyances by gravity. Use of the side discharge may reduce the service life of the silo, as they alter the grain flow regime inside the silo and bring dynamic forces and deflections not normal for circular silos. If the use of a side discharge system is chosen, it should only be designed and supplied by SCAFCO and be properly installed by an authorized SCAFCO dealer and their silo erector.

SCAFCO silos are designed for specific amounts of grain and are to be loaded and unloaded properly at all times. If a silo was not designed to include a side discharge system, improper loading and/or unloading may cause the silo to fail. Never unload a silo from sidewall locations without the proper installation of an approved side discharge system. Failure to do so will result in silo failure.



### **IMPORTANT GUIDELINES FOR SIDE DISCHARGE USE:**

- Side discharge systems are designed for clean, dry grain only. Do not use with poorly flowing grains or other materials. •
- Do not use the side discharge system until at least 90 days after the first complete filling. •
- The side discharge system must be located at least 90 degrees from any door or access panels. •
- NEVER fill a silo while discharging from a side discharge system.
- NEVER unload from the side discharge system while unloading from the center or intermediate sumps.
- Grain MUST NOT be discharged more than four rings at a time through the side discharge system without coning-down • the grain with the center discharge sump. After coning-down the grain, the side discharge may again be used for another four rings maximum.
- If grain has been completely discharged from the side discharge system (heeding the four rings at a time rule above), • the silo MUST be completely emptied through the center discharge sump before refilling the silo.
- NEVER refill the silo unless the grain is in a cone-down position.
- Side discharges are not to be used as a primary outlet for grain. Standard center and intermediate silo discharge sumps and conveyors must be installed and used as the primary discharge method.
- Side discharges MUST be installed in the center of the wall sheet and no lower than the fifth ring, unless otherwise designed by SCAFCO.

Silos with two side discharge systems:

- Side discharge systems must be placed 90 degrees apart and on the same ring, unless otherwise designed by SCAFCO.
- Only use one side discharge system at a time. •
- For silos 90 feet in diameter or larger, two side discharge systems must be placed 180 degrees apart and on the same • ring, unless otherwise designed by SCAFCO.
- For silos 90 feet in diameter or larger, alternate the use of the side discharge systems to reduce the stress on the silo.
- Unload no more than four rings of grain before switching to the other side discharge. •

### **REFILLING AFTER SIDE DISCHARGE USE:**

After the grain has been drawn down to the level of the side discharge gate, the grain MUST be withdrawn from the center to form a uniform inverted cone. The formation of the inverted cone in the center of the silo will help evenly distribute lateral forces to the silo walls.

If this process is not followed before grain is added to the silo, the distribution of grain will cause uneven lateral forces on the silo walls resulting in reduced life of the silo, possible structural failure, economic loss, and personnel injury.



# **Special In-Silo Drying Instructions**

SCAFCO silos are offered in stiffened and non-stiffened models for specific materials being stored and aerated.



Additional loads on the silo sidewalls, roofs, and floors can be created by improper drying methods. If high-moisture grain is loaded too deep and too fast, any unstiffened silo wall can be overloaded.

Level load 3 to 4 ft. [915 mm to 1220 mm] of wet grain into silo and dry-down to 16% moisture before adding additional wet grain. This procedure must be followed until the silo is full.

If silo is equipped with a stirring device, it is suggested that it be run continuously while filling, and initial grain filling depth not exceed 6 ft. [1830 mm]. This grain must be dried to 16% moisture content before adding additional grain for best drying results.

If these procedures are not followed, and the filling rate exceeds the drying rate, buckling of wall sheets can occur. The reason for this failure is that the bottom grain dries and shrinks, allowing the wet grain above to be supported by the silo wall only. Failure generally develops in the area of the drying front.

Standard storage silos are designed to store dry, free-flowing grain with a density up to 52#/cu. ft. [832kg/cu. m.]

Start up with stirring augers near wall. Augers should be "free" prior to start-up. If operation of the stirring device is to be stopped, stop it with the down-augers near the outer wall of the silo. If the device stops or stalls for any length of time, the auger carriage must be supported by the grain surface before restarting. Turn-off all power and rotate vertical augers by hand (use pipe wrench) to free them before restarting.



Care should be taken not to load grain into silo above the level of the stirring device.



DON'T

**DO** Start stirring augers near the silo wall.

# **Venting and Airflow**

Airflow management will be an important factor in not only maintaining high grain quality but also in protecting your grain silo from depreciating too quickly.

A positive airflow system and a negative airflow system will provide your grain silo with all the same benefits. However, due to the nature of both, a positive airflow system is generally preferred because it allows for easier evaluation of the grain quality.



Grain silo roofs are not designed to withstand excessive differences in air pressure between the inside and outside of the silo. General recommendations are that the minimum area for air escape should not be less than twice the cross sectional area of the main duct of a properly designed air distribution system. In conditions of high relative humidity and near freezing temperatures, be alert to the possibility of frost buildup and take preventative measures.

When there is inadequate air flow at the vents, damage can occur. In the case that a fan pushes air and roof vents are not open, then the internal pressure will "dome" the roof. If there is not an adequate air inlet from the roof vents, the vacuum from the aeration fan will pull the roof in.



Internal pressure "domes" roof



IMPORTANT: Roof vents must always be free from frost and debris to allow adequate airflow.



# **The Dangers of Entrapment**

Grain silo entrapment accidents can affect people of all ages and levels of experience. It is important to always follow safety guidelines and avoid situations that could be hazardous.

*Grain entrapment is 100% preventable. Exercise caution around all equipment and machinery at all times*. Grain silo entrapment can happen in a matter of seconds. Prevention, as well as emergency response, will play a critical role in the survival of your crew.



# The Speed of Entrapment

This chart contains only time estimates. Entrapment may occur more quickly or slowly than estimated.



Farming and ranching businesses are the eighth deadliest occupations in America. Make sure to do all you can to ensure the safety of your workers.

# **Common Causes of Grain Entrapment**

- Free flowing grain hazards
- Bridging hazards
- Avalanche hazards
- Entrapment from unintended grain discharge
- Free standing grain hazards

Even if you are a family-owned farm and are exempt from OSHA guidelines, you are still susceptible to all of the same hazards. It is important that you are familiar with all safety protocol and follow safety procedures at all times.

SCAFCO Grain Systems offers Entrapment Prevention Anchor Kits (EPAKs) with every bin and silo. These kits are inexpensive, easy to install and may save a life. Please install your EPAK when assembling your silo. If you need EPAKs, please contact us at info@ SCAFCOgrain.com or call us at +1 509-535-1571.

### **Personnel Safety**

Personnel may be exposed to hazards while operating and performing maintenance on the system. One of the biggest hazards in grain storage silos is the potential for being buried alive in the grain mass inside the silo.



# Bridging Hazard

A worker can become entrapped quickly as an unloading auger draws grain from the top center, forming a surface cone as the silo is emptied.

Moldy grain can form a thick, hard crust or "bridge" on top of the grain mass. When grain is discharged below this crust, a hollow cavity forms beneath the bridge. The weight of a worker on the bridge will cause it to collapse, partially or totally submerging him. Shifting grain can make it difficult to determine the worker's location. Use a pole or other object to free the bridge from the silo roof hatch or from the inside ladder while being securely tied to the ladder. Never stand on the grain surface.



# Avalanche Hazard

Grain in bad condition can cake in large vertical columns against the silo wall. Workers inside the silo may try to dislodge it by poking it with a stick or a shovel. This can cause a grain avalanche, completely burying workers. Use a body harness and safety rope that is securely tied to the exterior of the silo or a roof component. Work from the top to the bottom of a vertical grain wall, staying above the highest part of the wall. Be prepared for the entire wall of grain to break free and fall at any time.

- Grain spoilage or fumigation inside a silo could create atmospheres harmful to personnel. When
  fumigation occurs, follow all instructions for placing warning placards preventing entry into silos. If
  unhealthy situations are suspected, vent the silo, operate the aeration system, or use power exhausters
  to evacuate unhealthy air.
- Never enter the silo without an accompanying observer.
- Proper fall protection devices or harness or safety lines should be used when climbing ladders, roofs, elevator towers, catwalk supports, etc. or when entering silos from the roof hatch.



Every facility must make their own maintenance and safety program. The program must take care of their own special safety and maintenance needs and requirements on a daily, weekly, monthly, or annual basis. It is important to perform maintenance as the need arises. Putting off routine repairs on even seemingly small things could lead you to need much larger repairs down the road.

- A routine walk around the silo can be done using the checklist on page 25.
- A systematic checklist should be developed for each of the major components of the grain storage and handling system. Inspections should be carried out on a regular basis.
- A routine walk around a silo should include the following major items:

### **Roof Cap**

- Check that the roof cap has not shifted position due to inadequate anchorage to the roof, wind damage to the spout, or other factors.
- Inspect the overhead conveyors or spouts.
- Ensure that the cap's weather seal to the roof is adequate and the spout's connection to the cap is tight enough to prevent water from entering the silo in this area.

### Roof

- While climbing the roof, ensure that the roof ladder cleats are all tightly bolted to the silo roof. Tighten any loose bolts.
- Check for unusually large amounts of corrosion on all cleats or steps, remove rust and paint the cleats where required.
- Observe the silo roof panels from the peak of the silo.
- If the supporting ribs have been damaged or are buckled, try to determine the cause of the damage.
- An extremely high wind can tear or lift roof panels off their connection to the wall or damage the roof clips. Repair as soon as possible to prevent further damage or roof failure in future high winds.
- If the silo has a roof stairway, check all treads for soundness, tighten any loose bolts and paint any excessively corroded areas. Check the anchorage of the stairway to the roof.
- Inspect splices of roof support ring. Tighten any loose connections.

### **Roof Vents**

- Roof vents should be checked for blockage caused by dust, dirt, debris, frost, ice, etc.
- Check all gooseneck roof vents for plugging of the bird screen. For pressure systems, bird screens need to be free of all debris to allow fan driven air to escape the silo, or the silo roof will be





damaged. Suction systems also need to be free of debris, or the silo roof can be damaged, especially on cold, frosty nights.

• Grain piled in the roof area must not block the roof vents. Blockage of the roof vents with grain will restrict the effective vent area by 95% to 98%.



### **Catwalks and Supports**

Catwalks supporting overhead conveyors are often attached to steel structures bolted to the silo sidewall.

Improperly designed and fabricated catwalk supports supplied by others can place stresses on the silo not anticipated by SCAFCO. SCAFCO can certify the catwalks are capable of dead and live loads from the conveyors, as well as high wind loads.

- Check the attachment and observe connections between the catwalk support structure and the silo wall.
- Catwalk structures should be vertical (plumb).
- Check for bent braces, loose bolts, or sidewall damage caused by high wind loads.

# Ladders

- If the ladders are over 20' (6.10 m) in height, they should be guarded by safety cage, which provides a secondary lifeline for workers climbing toward the roof.
- If ladders on the silos are not equipped with safety cages and landings at least 30' (9 m) apart, install the necessary equipment.
- While climbing the ladder, check for any worn or corroded rungs.
- Replace damaged rungs; tighten all bolts connecting the ladder sections together, or the ladder to the wall.
- Check any existing safety cage(s) for sharp projections that would injure workers and remove the projections.
- Ladder rungs should be a minimum of 7" (175 mm) away from any wall.
- When climbing the ladder, check visible bolts.
- Determine if any bolts are loose or missing. If a bolt is missing, try to determine the cause, replace it, and check adjacent bolts for tightness.
- If a sheared bolt is discovered, it could be an indication of more serious problems.
- Contact SCAFCO or consult with an engineer to determine the seriousness of the bolt problem.



# Silo Walls

- Walk around the silo on a weekly basis, checking for any missing bolts, sidewall bulges, buckled or torn sheets, or any unusual visual changes in the appearance of the silo.
- Seal the base of the wall to the foundation with a base sealer.
- Contact SCAFCO for a detailed inspection of any serious structural problems detected.

# Stiffeners

The purpose of internal or external vertical stiffeners is to transfer friction and drawdown loads from the corrugated steel sheets to the silo foundation.

- Stiffeners landing on top of aeration trench or conveyor trench covers should be fully supported under these covers to transfer the friction and drawdown loads directly to the concrete foundation.
- Visually inspect the stiffener splices to ensure that the upper stiffener is not sliding past or behind the lower stiffener or that splice plate bolts have not sheared off.
- If the base plate is not bearing uniformly on the silo foundation, it could cause stiffener buckling at some level above the base.
- Shim all stiffener base plates or fill the void with an expanding cement grout.
- Ensure stiffeners are properly anchored to the foundation. The base of the stiffener can move outward as the silo diameter increases under load.
- Stiffeners shall rest firmly against each other at all splice joints and shall also rest firmly on the floor.
- Contact SCAFCO if bent or buckled stiffeners are found during inspection.

Gap between stiffeners should ~ never exceed 1/4" (6.4mm)





There should never be a gap between base plates and the floor. If a gap exists, the problem can be remedied with shims.

### Silo Door

- If doors are supplied with latch pins, all latch pins must be properly installed before filling the silo.
- Check the silo door and the corrugated steel sheets around the door.
- If any sign of damage to the door or adjoining wall sheets is observed, contact SCAFCO and take necessary preventative measures.



Latch pins

Note: Store all SCAFCO manuals in the manual pocket provided on the inside of the outer door panel.



# **Silo Foundation**

 Check the silo foundation for major concrete cracks or differential settlement. Major cracks or concrete breaking away from the foundation is an indication of a serious problem. If cracks develop around the anchor bolts, it often leaves that portion of the silo without anchorage, making the silo susceptible to wind or seismic damage.



 Check to see that the base of all the steel sheets are bearing uniformly on the foundation around the silo circumference and that the base seal is intact. The base seal

The silo foundation is an extremely important element related to the structural integrity of the silo.

- the silo circumference and that the base seal is intact. The base sealant may have to be renewed annually or biennially to prevent water seeping under the wall and spoiling grain inside the silo.
- Check the silo base for corrosion, remove rust and paint the affected area with a rust-inhibiting paint.
- If excessive corrosion is observed, contact SCAFCO to order replacement wall sheets.

# Tunnels

Tunnels are often installed underneath large silos for discharge equipment.

- Serious buckling or failure of the silo wall just above the tunnel wall/foundation connection can occur if the tunnel floor and foundation adjacent to the tunnel are not properly supported by the soil or if it is not properly connected to the rest of the silo foundation.
- If the silo foundation is seen to be pulling away or settling away from the tunnel wall, contact SCAFCO or your local structural engineer for proper instructions or measures to ensure that the silo is not damaged.

# Silo Tunnel Roofs and Removable Conveyor Covers

- Silo tunnel roofs should be inspected on a regular basis for cement spalling, cracks and significant deflections. Inform the concrete/civil works contractor of any significant appearance of cracks or impending failure of silo tunnel roofs.
- Removable conveyor cover plates must be fitted, flashed and sealed to prevent accidental leakage into conveyors, which could result in eccentric discharge of grain from silos.

# **Hopper Bottom Silos**

Hopper bottom silos require the same safety and maintenance checks as flat bottom silos. The steel hoppers represent an important structural element of this type of silo.

- Periodically check the connection between the hopper segments and the silo wall or hopper compression ring for any cracks, tears, or slits in the wall sheets or hopper segments.
- Look for any sheared bolts or indication of overstressed areas.
- The first filling of the silo will show some movement between each of the connected components of the silo due to the slightly oversized factory-punched holes provided for ease of making the connections. At the initial filling, it is possible to have the hopper move downwards as much as 2" (50 mm) as the bolts move out to bear against the sides of the holes. Plan for this expansion in the installation of discharge equipment.
- Check hopper bottom silo legs or columns for vertical alignment, any unusual deflections, or twisting. Braces should be fully connected at all times and bolts remain tight.
- Check anchorage of the columns and make sure all anchor bolts are fully connected and nuts are tight.





# **Aeration System**

- Inspect the aeration system for grain leaks into the trenches. Find the source and flash, seal, or caulk. Remove any grain remaining in the trenches.
- Check aeration system supports and repair any damage.
- Patch or replace any damaged aeration decking.
- Check the fans outside the silo.
- Grease the motor bearings (if required) at least twice annually.
- Clean and paint any rust spots developing on the fan or transition.
- Fans should not be switched on until a substantial amount of grain layer completely covers the drying or aeration floors.



# **Aeration System Yearly Startup Checks**

- Yearly startup checks must be done with the MAIN POWER LOCKED OUT.
- Because of the danger of flying debris, protective eyewear/safety glasses must be worn during assembly, installation, and maintenance or servicing.
- Check fan-transition-silo connection for proper seal. Replace any caulking or gasket as needed.
- Check for any obstruction inside housing that would prevent the blade/wheel from rotating freely.
- Check electrical components and connection.
- Check silo roof vents for any obstructions that would cause ventilation restrictions.
- Press the START button/switch and immediately press the STOP button/switch to check for proper blade/wheel rotation. Centrifugal rotates counter clockwise looking at guard end.
- Foundations may settle over time. Check fan leveling feet. All bolts should be tightened to equally carry fan weight while keeping fan level to the transition.
- Failure to snug bolts evenly will cause fan to twist or rock and may contribute to fan housing vibration and wheel clearance problems.

### Beginning of each drying season

- Lock out power and remove inlet screen. Check for foreign material on fan blade. With power off, turn fan by hand to make sure it rotates freely.
- Lubricate fan motor bearings with high temperature grease as indicated on motor nameplate or motor fact sheet. Do not over grease. Check ventilation openings in motor for any blockage.
- Check fan wiring. Look for loose connections, bare wires, or rodent damage.

### After drying season

- The balance of a centrifugal blade is critical. Vibration can cause the fan housing to crack. To prevent this, check behind the blade for dirt, dust, or foreign material.
- Cover fan inlet to keep out weather, pests, and to prevent "wind milling" which can cause wear on the START switch in single phase motors.

### **During off season**

• Every six weeks, remove inlet cover and operate fan to redistribute grease in bearings. Let motor warm enough to force out any accumulated moisture. Make sure control box cover is in place and secured. Turn off power.

# **Temperature Cable**

### and Supports

- Do not install more than one temperature cable per rafter.
- Check requirements for temperature cable supports in the temperature cable technical manual.
- Do not use weights on the bottom of temperature cable. If weights are used, they must be removed from cables after installation and before filling the silo. Failure to do so can cause roof damage due to additional loads.
- Make sure anchor plate lies flat on floor beneath cable.
- Tie down with recommended string.



# **Cleaning and Maintenance**

- If spoiled or crusted grain is found on the silo floor or sides, remove the grain and thoroughly clean the affected area.
- Maintain painted elements by repainting if corrosion occurs.
- Seal or grout any cracks found in the floor.

# Safety

- All drive and moving parts must be guarded per the manufacturer's instructions, as well as those regulations issued by insurance companies, OSHA, national and international guidelines, etc. before any equipment is put into operation.
- After a silo has been completely discharged by gravity through the center gate and the intermediate gates have been opened and grain is completely discharged, all gate openings must have safety grates installed over the openings to prevent injury to personnel entering the silo for final clean up.
- The silo conveyors must be locked out and tagged out prior to silo entry by personnel to prevent accidental conveyor operation until suitable safety grates are in place over floor openings and gates.
- Keep hands, feet and clothing away from moving parts. Loose clothing can become entangled in rotating parts and cause serious injury.

# **Treating Rust**

White rust, also known as storage stain, is a bulky, white, powdery deposit that forms rapidly on the surface of galvanized coatings under certain specific conditions. White rust is the physical appearance of corrosion to the galvanized zinc layer on galvanized steel parts.

Moderate white rust appears as a heavy chalky coating on the galvanized parts. In more serious cases the rust can appear as a thick chalky coating and may even show signs of a black powdery coating or red rust.

### To treat moderate white or red rust:

- Apply an Oakite or white vinegar solution\* using a wire brush or other lightly abrasive pad.
- 2. Scrub the area until you reach bare metal and all the rust is removed.
- 3. Rinse and allow the area to dry.
- 4. Paint with a light film of aluminum-based paint to prevent rust from reforming.
  - \*The white vinegar solution can be made by mixing one part vinegar to four parts water.

If a black powder forms before the area can be treated, you should consult with a SCAFCO representative to determine if replacement parts are needed. Any time the rust has gone completely through the metal, those parts should be removed from service and replacement parts should be ordered.

Occasionally, red rust stains are seen on galvanized steel surfaces, like silo roofs. This likely is not the corrosion of the base metal, but is simply a rust stain from the untreated carbon steel overhead rusting with subsequent drips onto galvanized surfaces below. This is a surface stain and is not the corrosion of the base metal under the zinc coating. The stain may be removed with a light scrubbing with an Oakite or vinegar solution, then be painted or treated to prevent future rust stains.



New galvanized steel

White rust corrosion

Passivated galvanized steel



Red rust

# **Fretting Corrosion**

# Fretting Corrosion (Transit Abrasion) on Galvanized Sheet

Galvanized sheet surfaces sometimes exhibit a surface imperfection that appears as permanent black spots, marks, lines, or patches. This defect has many names, including transit abrasion, friction oxidation, wear oxidation, and chafing; all being terms for a form of erosion-corrosion known as fretting. While superficial, black fretting marks on galvanized sheet are almost impossible to remove, and are not the direct result of bulk water damage.

Fretting is caused by relative motion between the wall sheets while in transit from the factory to the job site. The contents of the heavy wall sheet bundles may vibrate in the container allowing fretting to occur.



Fretting marks on galvanized sheet are surface oxide phenomena that can be an aesthetic issue, but there is no evidence they have a negative affect on corrosion resistance. Product with fretting marks is not a warrantable condition and is generally suitable for use.

# **Electrical Safety Precautions**



Before opening and servicing the silo shut off and lockout electrical power.

All electrical installations must be performed by a licensed electrician that complies with national, state, and local requirements. Contact SCAFCO if you have any questions about appropriate motor loads, operating conditions, or equipment compatibility. Do not leave anything to chance.

# **Disconnects and Grounding**

It is important that all silos have lockout devices installed at all times. These devices will prevent any electrical equipment from turning on while you perform routine maintenance. Lockable disconnect switches should open all control enclosures containing hazardous voltage wiring.

Electrical equipment must be grounded. Grounded electrical devices will help protect from electrical shock that could occur as a result of lightning or static electricity.

# Safety Controls

Safety controls must be installed around electrical components to prevent self-restart following a power failure. Breakers are an extremely important component as they can help prevent hazardous conditions following a power failure.

# **Inspections and Maintenance**

Always ensure all electrical devices are shut off and locked before performing inspections and maintenance. Failure to do so can result in serious injury and loss of life.



Use this table as reference in determining the gauge or thickness of the corrugated reinforcing sheet. Contact SCAFCO Engineering Department for penetrations or openings greater than 27" (685 mm) or for openings through laminated wall sheets.

- Penetrations or field-cuts through silo wall sheets for conveyors, aeration equipment, or other requirements should be reinforced.
- The corrugated reinforcing sheet or corrugated patch sheet shall be full-height and bolt to the horizontal seams on the top and bottom of the adjacent wall sheets.
- The corrugated reinforcing sheet may be cut short of the vertical bolt seams. It must extend to a minimum of 6" (150 mm) beyond either side of the penetration.
- The corrugated reinforcing sheet must be field-drilled and bolted to the wall sheet in a pattern matching the adjacent vertical bolt seam.
- Fasten the corrugated reinforcing sheet to the wall sheet using the same SCAFCO supplied bolt diameter and bolt grade used on the existing wall sheets. Use SAE Grade 8.2 or equivalent bolts only. **Do not use Grade 2 bolts.**
- Limit one (1) penetration or field-cut per wall sheet.
- Do not locate penetration or field-cut on a vertical bolt seam.

Corrugated Reinforcing Sheet Gauges				
Existing Silo Wall Sheet Gauge	For penetrations up to 13" (330 mm) high	For penetrations greater than 13" (330 mm) up to 19" (480 mm) high	For penetrations greater than 19" (480 mm) up to 25" (635 mm) high	For penetrations greater than 25" (635 mm) up to 27" (685 mm) high
20 (0.86 mm)	18 (1.17 mm)	18 (1.17 mm)	17 (1.32 mm)	16 (1.47 mm)
19 (1.04 mm)	18 (1.17 mm)	18 (1.17 mm)	16 (1.47 mm)	16 (1.47 mm)
18 (1.17 mm)	18 (1.17 mm)	18 (1.17 mm)	16 (1.47 mm)	15 (1.63 mm)
17 (1.32 mm)	18 (1.17 mm)	18 (1.17 mm)	16 (1.47 mm)	14 (1.83 mm)
16 (1.47 mm)	18 (1.17 mm)	16 (1.47 mm)	13 (2.24 mm)	12 (2.59 mm)
15 (1.63 mm)	18 (1.17 mm)	16 (1.47 mm)	12 (2.59 mm)	11 (2.95 mm)
14 (1.83 mm)	18 (1.17 mm)	15 (1.63 mm)	11 (2.95 mm)	10 (3.30 mm)
13 (2.24 mm)	17 (1.32 mm)	14 (1.83 mm)	10 (3.30 mm)	2 x 13 (2.24 mm)
12 (2.59 mm)	16 (1.47 mm)	13 (2.24 mm)	8 (3.76 mm)	2 x 13 (2.24 mm)
11 (2.95 mm)	16 (1.47 mm)	12 (2.59 mm)	2 x 13 (2.24 mm)	2 x 12 (2.59 mm)
10 (3.30 mm)	15 (1.63 mm)	11 (2.95 mm)	2 x 12 (2.59 mm)	2 x 11 (2.95 mm)
8 (3.76 mm)	14 (1.83 mm)	10 (3.30 mm)	2 x 11 (2.95 mm)	2 x 10 (3.30 mm)

# **Considerations That May Void Your SCAFCO Warranty**

### Roof

Severe structural silo roof damage may occur if fans or other air moving devices are operated during certain high humidity or cold weather conditions. Roof ventilators may freeze over and restrict airflow causing excessive vacuum or internal pressures. Refer to Venting and Airflow on page 11.

### Walls

Silo wall failures can occur due to the following:

- Silo is filled off-center or eccentrically loaded.
- Unloading from door or off-center floor gate. Uneven wall pressures may occur allowing the wall to
  flatten directly nearest the unloading point, and damage can be seen above and several feet or meters
  to either side of this area. In some cases in unstiffened silos, the buckling of sheets will be seen on the
  opposite side of the silo due to the uneven wall stresses caused by this unloading method.
- In stiffened silos, failure may be seen in wall sheets nearest the unloading point. Severe sheet seam and stiffener damage can occur causing complete silo failure. Internal grain pressures change when only a few bushels of grain have been removed. Failures can be caused by incorrectly unloading even small amounts of grain.
- If silo has a perforated floor on columns, and the columns fall, silos can be shifted sideways causing both sidewall and roof damage.
- Radial cracks in the foundation are a danger signal, meaning the foundation is growing outwardly and pulling the silo with it.
- Stiffened silos must be leveled so a vertical dimension between adjacent stiffeners does not exceed 1/4" (6 mm). If stiffeners are not level, the bolts attaching the stiffener to the wall sheet, as well as the vertical and horizontal seam bolts, may become overstressed and shear, causing total failure.
- See "Special In-Silo Drying Instructions" on page 10 for additional reasons for failures.

Failure to follow any installation, operation or maintenance instructions by the manufacturer or failure of the product resulting from exposure to corrosive or abrasive materials, misuse, accident, normal wear and tear, modifications, improper maintenance, or improper storage prior to erection may void your SCAFCO warranty.



Glossary				
Center Gate	Also known as center floor outlet, center sump, center well, center port, center floor gate, and center unloading gate. This gate is located at the center of the silo floor.			
Concentric Loading	Filling of silo through the center of roof peak cap with grain falling into the silo straight down. If the grain drops at an angle due to the feed spout orientation and/ or grain momentum, a properly designed grain cushion box (dead head) should be installed on the roof cap or a transition should be installed under the roof cap to force the grain to drop straight down and prevent eccentric loading.			
	For silos installed with gravity or mechanical spreaders, this device should be installed and properly adjusted to spread the grain evenly to avoid eccentric loading of grain.			
Concentric Unloading	Removal of grain from the silo by using the center gate.			
Eccentric Loading	Filling of silo in such a manner that the grain does not drop straight down from the center of the roof peak thus forming a non-concentric cone of grain.			
Eccentric Unloading	Removal of grain from the silo by using a gate or a number of gates other than the center gate or by using a discharge gate located on the silo wall or silo door. Eccentric unloading results in asymmetrical unloading forces that may cause the silo wall or stiffeners or both to buckle.			
Grain Silo	Also called grain bin, grain storage silo, grain storage tank, or corrugated steel silo.			
Installer	Also known as contractors or silo erectors.			
Intermediate Gate	Also known as side floor outlet, intermediate sump, intermediate well, intermediate port, intermediate floor gate and intermediate unloading gate. This gate or a number of these gates are located on the silo floor between the center gate and the silo wall.			
Roof Cap	Also called roof peak cap.			
Side Discharge Kit	This is composed of anti-dynamic flumes and a side unloading chute or outlet for installation on silo wall. Only SCAFCO designed and supplied side discharge kit installed by an authorized dealer or installer is allowed on SCAFCO silos.			
Stiffener	Also called reinforcing columns, stiffener columns, and silo wall stiffeners.			
Wall Sheet	Also called body sheet, corrugated steel panel, side wall, and silo wall.			

# Silo Safety and Maintenance Checklist

General Information         Silo model         Manufacturer         Installation date         Facility silo ID         Last date of maintenance         inspection         Owner/operator's manual         Construction manual location         Foundation         Silo elevation readings         Concrete levelness for stem wall         and floor         Drainage         Water drains away from silo         foundation and stemwell         Seal between silo base         angle and concrete         foundation         Concrete cracks greater than         1/32" (1mm) wide         Digital photo of area         Area of exposed rebar         and note location         Fans supported according to silo         manufacturer's specification         Anchors         None missing         Clean and free from rust         Proper washer         Stiffeners         Aligned end of stiffeners         Splice hardware tight and         aligning connection         Properly shimmed         Missing or broken bolts         Evaluate for bowing         Electrical Checks	Ladder (Inside, Outside), Platform All hardware installed and tight Attaching brackets Ladder splices Ladder cages Ladder obstructions: OSHA compliant installation (USA) Inspect for signs of deterioration (rust, cracks, separation, etc.) Roof Hardware in place and tight Roof vents Screens are clean Clear any debris buildup Ensure center filling Inspection of aeration tunnels Proper support Anchored to foundation Sidewall Missing or broken bolts Rusted body sheets visible on exterior or interior of silo Document and record location(s) Wind ring(s) aligned, connected and in proper position Mounting brackets secure Damaged or dented wall sheets Aeration Floor Clean under floor and aeration trenches	Temperature Cables         Proper roof attachment and location         Vertical orientation between floor and roof         Inspect for damage         Tie down after sweeping         Observe for damage of cables         Replace if damaged         Door(s)         Door panels aligned on pins         Door latch bars adjusted         All bolts installed         Door sealed properly against leaking         Fan and Aeration System         Inspect for spillage and leaks, cracks         Inspect for center loading         Observe for center loading         Observe for center loading         Observe for center unloading         Clear any debris buildup anywhere         Bracing hardware tight - nothing missing         All bracing installed         Paint any areas that may appear to be rusting         Check level of support structure legs         Inspect silo aeration attachment
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