FLOW eHANDBOOK
WWW.CHEMICALPROCESSING.COM
CHEMICAL PROCESSING
LEADERSHIP | EXPERTISE | INNOVATION

MAKE THE RIGHT MOVES IN Fluid Handling

PutmanMedia®

TABLE OF CONTENTS

AD INDEX

Head Off Centrifugal Pump Problems

Attention to head tolerances can prevent poor performance and rework

By Jonathan R. Webber, Duncan J. Blaikie and Theresa R. Winslow, Fluor Canada

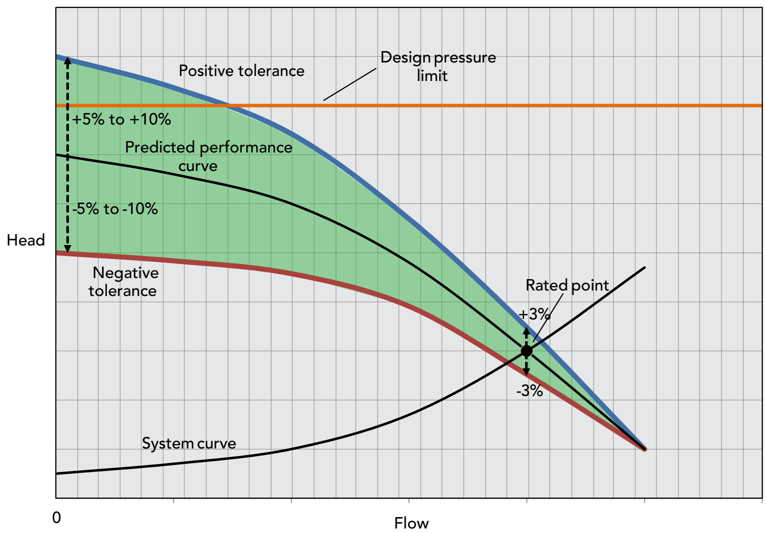
The oil and gas industry heavily relies upon centrifugal pumps designed to meet API-610 specifications [1]. Familiarity with the pump head tolerances allowed under API-610 is necessary to avoid disappointment with the performance of the purchased pump and additional costs due to rework. These tolerances can result in significant deviation between the expected and actual performance for high-head pumps (e.g., injection or hydrocracker charge pumps). While API-610 provides many other specifications and tolerances, here we'll focus on the tolerances related to the differential head at rated flow and maximum shutoff head.

As part of the procurement cycle, each potential pump vendor will recommend a particular unit and include a predicted performance curve. This performance curve demands careful evaluation to ensure the pump meets all specified requirements. During this review, the process engineer should check that the specified rated differential head requirement is met and that the maximum shutoff head doesn't exceed any system limitations.

After the purchase order is awarded and the pump is built, conducting a certified performance test is sensible. The certified

Rated Differential Head, m	Rated Point, %	Shutoff, %
0–75	±3	±10
>75–300	±3	±8
>300	±3	±5

PERFORMANCE TOLERANCES
Table 1. API 610 [1] considers these tolerances acceptable.



SHUTOFF HEAD CONCERN
Figure 1. Positive tolerance at shutoff may lead to head that exceeds system design.

head at the rated flow and pump shutoff must meet the specified tolerances of the predicted performance described in the bid. Table 1 shows the allowable tolerances given in API-610.

POTENTIAL PROBLEMS

Let's now look at two scenarios where the allowable rated and shutoff head tolerances could create unexpected rework and impact project schedule/costs. Brownfield/revamp work can be particularly susceptible to risks because the pump must be integrated into existing systems and the flexibility to modify those designs may be limited.

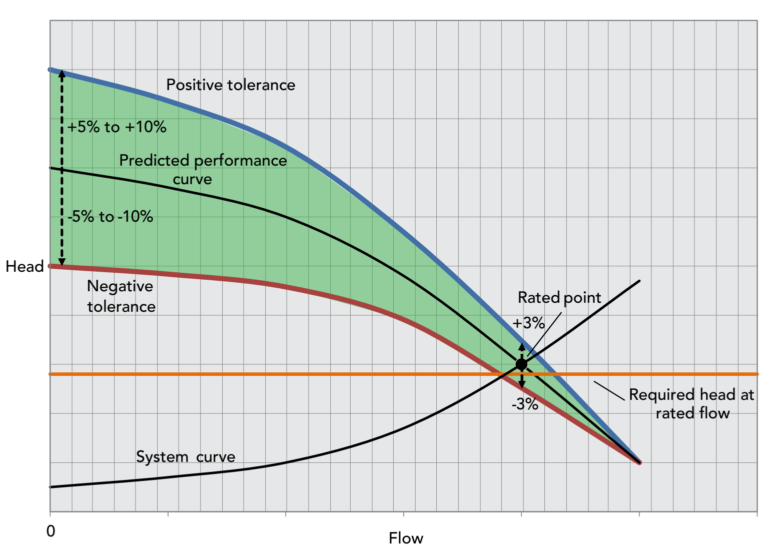
Scenario 1: Positive tolerance at pump shutoff exceeds system design pressure. The pump shutoff head typically is selected such that it won't exceed design pressures of downstream systems. In certain revamp scenarios to avoid changing piping classes, rerating the piping/vessels or adding a pressure safety valve/high-integrity pressure protection system may be necessary to avoid exceeding design pressure. The proposed pump may be acceptable per the predicted shutoff head — but once the API-610 tolerances are applied, the actual shutoff head could be 5 to 10% higher. Figure 1 illustrates how the allowable positive tolerance at shutoff can cause a certified performance curve to exceed the design limits of an existing system.

In this scenario, the pump impeller would need to be retrimmed and the pump retested to ensure the system design limits aren't exceeded. This also may impact the rated performance and feasibility of the selected pump.

Scenario 2: Negative tolerance at rated point results in an underperforming pump. Without considering the allowable tolerances of the rated head, the performance of the preliminary curve may appear acceptable. However, a negative deviation of the rated head may lead to a pump that underperforms. For example, a high-head cavern injection pump may require a rated head of around 2,500 m. API-610 allows a tolerance of ±3% of the rated head. If the certified pump has rated head 3% less than the predicted curve, then the pump could lose up to 75 m of developed head. In typical liquefied-petroleum-gas service, this can result in a loss of up to 370 kPa of developed head, which may be significant. The process engineer should consider the potential for reduced head and determine if the system has sufficient hydraulic capacity to absorb deviations between the predicted and certified performance. Figure 2 illustrates how the allowable negative tolerance at the rated point can cause a certified performance curve to fail to meet pressure requirements.

If the system lacks sufficient hydraulic capacity, the pump impeller either would need to be replaced and retested, or a reduced flow may need to be accepted. However, depending upon the design limitations of the system, replacing the impeller to gain head could lead to exceeding the system's design pressure at pump shutoff.

In either scenario, unexpected modifications to impellers and retesting can create additional costs and impact schedule. Pump disassembly and impeller trimming or recasting could be a lengthy process depending upon the size and style of pump. For example, large high-head multistage pumps would take longer to modify. The pump purchaser will bear the costs associated with the required impeller modifications and retesting along with any schedule delays if restrictions on API-610 tolerances weren't specified and agreed upon earlier in the procurement process.



INADEQUATE HEAD ISSUE
Figure 2. Negative tolerance at rated flow may mean pump doesn't provide sufficient head.

In the worst case, an impeller modification may not allow the selected pump to meet the required conditions; this either would result in accepting a derated performance or switching to a different pump. If a different pump is necessary, the new procurement process would further delay the project.

HEED THIS HEADS-UP

Understanding the tolerances allowed under API-610 with regard to pump shutoff head and rated differential head can avoid costly rework and schedule delays. When specifying the required performance of a pump, the process engineer should identify any potential issues with API-610 allowable tolerances on pump performance and include a note on the datasheet that restricts the tolerances. By determining early on in the procurement cycle that full API tolerances aren't acceptable, the process engineer can help minimize risks to schedule and cost. ●

JONATHAN R. WEBBER, P.E., is a process engineer for Fluor Canada Ltd., Calgary, AB. **DUNCAN J. BLAIKIE**, P.E., and **THERESA R. WINSLOW**, P.E., are process engineers for Fluor Canada Ltd., Saint John, NB. Email them at Jonathan.Webber@fluor.com, Duncan.Blaikie@irvingoil.com and Theresa.Winslow@irvingoil.com.

ACKNOWLEDGMENTS

The authors thank Jeff McKay, lead mechanical engineer for Fluor at Irving Oil, for reviewing our draft. It was developed under the Fluor Calgary office Professional Publications & Presentations Program (P4), a mentorship program that encourages and assists first-time authors interested in developing publications.

REFERENCE

1. "Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries," API Standard 610, 11th Ed., Amer. Petroleum Inst., Washington, DC (2010).


viega
1
GERMANY

Set Your Sights on Better Flow

Use this primer to determine the right sight flow indicator for the application

By Mike Curnutte, L.J. Star

The ability to see what is happening inside a pipe can be invaluable to process operators. Despite technological advances, no sensor can equal the human eye, which has more than 94 million photo receptors.

A sight flow indicator is a device installed in a pipe to provide a visual means of verifying liquid flow for direction and approximate rate. Simple and low-cost, it also allows operators to observe the color and clarity of process fluids through a window.

The basic description of a sight flow indicator is a body with one or more viewing windows, usually with gaskets, and a way to mount the indicator to the pipeline, such as flanged (Figure 1), threaded or sanitary clamp connections. Depending on the manufacturer, sight flow indicators are available to fit standard pipe sizes ranging from ¼ to 16 in. and carry ANSI pressure ratings.

FLANGED MOUNT
Figure 1. Sight flow indicators offer a variety of mounting options, including flanged.

FULL VIEW FLOW INDICATOR
Figure 2. A full-view flow indicator is visible from all angles and allows ambient light to illuminate the flow.

TYPES OF SIGHT FLOW INDICATORS

Unlike sight glass windows that don't have indicating mechanisms, sight flow indicators might have passive components that are set in motion by the flow to indicate flow direction or intensity. If the flow indicator has indication components, a certain level of flow is required to set them in motion. Flow indicators without indication components are used when observing a process fluid's characteristics is more important than verifying flow. Because indication components complicate cleaning in hygienic systems, they rarely are used in sanitary applications.

360° view flow indicator. Also called a full-view, cylindrical-style or tube-style flow indicator, this type of flow indicator passes fluid through a glass cylinder that is visible from all angles (Figure 2). This allows ample ambient light to illuminate the flow. It is ideal for observation of process fluid for clarity, color, foam and other conditions and for the presence of moisture. Designs often feature impact-deterrent shields or sheaths made of plastic. This style of flow indicator is suited for lower-pressure systems with moderate flow rates. These indicators must be installed on pipes with minimal mechanical strain.

An alternative design has a metal shield or sheath with windows. This strengthens the indicator and protects it from moderate mechanical strain.

Note that 360° view flow indicators might be fitted with glass marked with a calibrated scale and used for level indication.

View-through flow indicator. This type of flow indicator has two opposing windows so that an operator can see the intervening flow of fluid lighted from behind, either by ambient light or with an attached luminaire. Unlike 360° full-view flow indicators, this design is suited for ANSI pressure classes, high temperatures and harsh fluid applications. This type can be ordered with a Teflon®-lined metal body for corrosive media (Figure 3).

Mount types include flange, threaded, butt-weld, socket-weld and clamp. Sizes depend on the manufacturer but generally range from ¼- to 16-in. diameters, with larger units

VIEW-THROUGH FLOW INDICATOR
Figure 3. A view-through flow indicator's windows enable operators to see fluid lighted from behind and can come with a Teflon lining for increased corrosion protection.

available as special order. Stock models come in pressure ratings ranging from 20 to 3,000 psi.

Flapper flow indicator. Flow indicators can be fitted with a hinged flapper or flag visible through the sight glass. The flapper is deflected toward the flow direction. Because the flapper's position changes in relation to flow force, it provides operators with an approximate gauge of flow. This style is best applied on horizontal pipelines, but it also can be used in vertical pipelines with upward flow. It is ideal for use with transparent solutions and gases, which cannot be observed directly, and for dark, nearly opaque fluids in which flow is difficult to observe.

Visual flow meters. Flapper-style sight flow indicators are available in which the flapper has a reset spring. The process fluid's relative flow overcomes the spring's force. A graduated scale is marked on the glass to indicate the flow volume. In simple applications this can be used as an alternative to an expensive flowmeter.

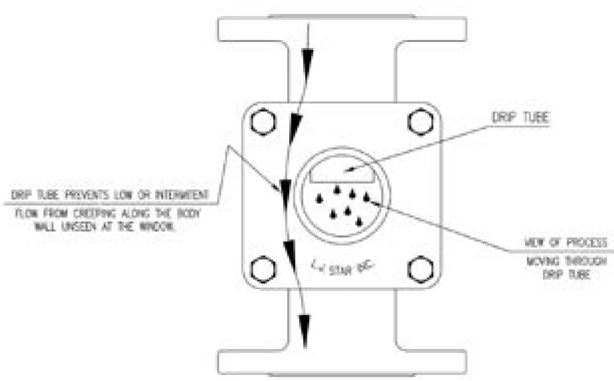
Some sight flow indicators use a weighted flapper or flag that indicates flow volume by its position on a calibrated scale marked on the sight glass. These flowmeters are factory-set for a specific flow of water at 20°C for a given pipe diameter. Therefore they are not useful for non-water applications.

Visual flowmeters work with one direction flow only.

Rotary flow indicator. Flow indicators might be fitted with rotors or impellers that are turned by liquid or gas flow. The rotors are mounted in the window view so operators can observe the direction and approximate speed of flow. This is particularly useful for clear gases and fluids, but the rotor is visible with dark fluids as well. This indicator operates in any position and with any direction of flow. Rotor-style flow indicators should not be used if the flow rate is very low because the rotating device or propeller might not turn.

Drip indicator. Drip indicators can be designed for drip observation or conventional flow indicators installed with a drip tube (Figure 4). Drips and low-volume intermittent flows might be observed in applications such as distillation. Because gravity is used, drip indicators normally are applied in vertical pipes with a downward flow. Nevertheless horizonal installation is possible in some applications.

Ball flow indicator. Flow moves a ball from the bottom of the indicator housing to a position at the top of the sight window. The ball is visible through the window so that flow is observed easily at a glance. The ball's suspension by the fluid indicates



DRIP TUBES
Figure 4. Drip tubes normally are used in vertical pipes with a downward flow and are good for distillation-type applications.

flow's presence. Because gravity returns the ball to its rest position, this style of indicator must be applied in vertical pipes with upward flow. Generally this is used with slow-moving fluids or gases and not with high-rate or turbulent flows.

Flutter indicator. The mechanisms for standard flappers and rotors cannot be Teflon-coated, so a flutter style indicator is a good choice for observing gases and liquids in Teflon-lined flow indicators. The movement of a thin ribbon of tough, non-reactive material such as Teflon might be observed though the sight glass window. Flutter's intensity indicates the flow's relative speed. Usually it is mounted inside the sight flow indicator so that it can be used for flows in a single direction only. Because the ribbon has so little mass, it is moved easily; therefore flutter indicators are ideal for low-speed process flow and light process media.

ADDITIONAL OPTIONS TO CONSIDER

Steam-heated jackets. These are available to cover view-through flow indicators. Only the sight glass window is not covered. The jackets prevent cool spots in a process and increase fluid viscosity.

Cameras. Sight ports can be fitted with video cameras that allow remote monitoring as well as recording. For hazardous environments, explosion-proof versions are available.

Lighting. Lights, also called luminaires, can be added to view-through and full-view style sight flow indicators. Generally these lights mount externally using a bracket, or the luminaire fits directly into a sanitary fitting for one-piece mounting right onto the ferrule or cover flange.

CONSTRUCTION MATERIALS TO CONSIDER

Metal. View-through flow indicators usually have cast-metal bodies. Commonly used body materials include carbon steel, iron, bronze and stainless steel. Stainless steel formulas offered might be 316, 304, Alloy 20, Hastelloy®, Inconel and Monel. PVC also is used, although for industrial and chemical processing it rarely is used. Not all styles and models are available in all materials.

Linings. In situations in which the process medium will react with metal, the indicator body can be made corrosion-resistant by adding a lining of Teflon, FRP or other non-reactive material. In addition, lower-cost body materials such as carbon steel can be made suitable for an application by adding such a lining. This approach most often is used to achieve cost savings compared to using indicator bodies made of more expensive alloys.

Gaskets. Gaskets are available in a range of materials, and their selection should be matched to an application's requirements, including operating temperature and compatibility with the medium handled. Common material choices include neoprene, Gylon® (PTFE), Teflon with an elastomer insert, butyl, Buna-N, silicone, fluorocarbon and graphite.

For hygienic applications, sight flow indicator O-ring seals are available. They often mount to the pipe ferrule using clamps. The sight glass windows are attached to the body in a similar fashion.

Glass. Soda lime glass and borosilicate glass commonly are used in sight flow indicators. Quartz glass, also known as fused silica, and sapphire are used only for special applications. Although acrylic and Lexan lenses are available, they rarely are used in industrial applications because of their limited corrosion resistance and temperature range.

In addition to the type of glass (its chemical composition) used, any glass can be strengthened by annealing or tempering.

Soda lime glass. Soda lime glass is common glass dating back to the ancient Egyptians. It is usable in operating temperatures up to 300˚F (150˚C), although in the case of alkaline media up to only 212˚F (100˚C).

Borosilicate glass. Borosilicate glass differs from soda lime glass in that some of the silica is replaced by boron oxide. It was developed in 1893 by a German scientist who found that adding boron salt improved glass' resistance to thermal shock and chemical corrosion and provided higher temperature capabilities (600˚F). "Pyrex," a trademark of Corning, is a brand of borosilicate glass.

Fused silica. Fused silica is made from fusing quartz crystals at high heat. Because no doping agents are added, this pure form of glass has superior temperature and thermal shock capabilities. It is specified for operating temperatures up to 1,000°C. It is more expensive than other types of glass and not as strong or durable as annealed borosilicate glass. Kel-F or PFA shields can be used to protect the glass from materials that could erode or etch it.

Sight glass lenses are available as plain glass disks that are bolted to the indicator body with intervening gaskets, or as sight glass windows in which the glass is fused to a metal frame during manufacture. Such fused designs are polished so there is no crevice between the glass and metal.

Fused-glass sight glass windows offer many advantages. The metal frame prevents overtorque or uneven bolt compression from affecting the sight glass. Fused sight glasses can be reused, but plain glass should be replaced after maintenance because it is exposed to mounting stresses that can chip or weaken it.

The biggest advantage of fused sight glass is strength. The metal ring holds the glass in concentric compression that overcomes the tensile forces that otherwise could break the glass. Like cement, glass is strong under compression but fragile under tensile stress. Compression gives glass amazing strength. In fact, under high compression the glass become slightly elastic, able to flex under pressure and continue service when it is chipped or scratched. Glass strength is critical for worker safety because glass fails catastrophically with explosive force.

Some people request sight flow indicators with dual glasses for safety and reliability reasons. Depending on the manufacturer, such designs involve either a lens made of multiple layers of glass or independent lenses that are sealed separately. Such designs offer redundancy and reduce the effect of thermal gradients across the glass. However, the glass strength should be calculated only on the inner glass lens, not on the combination of glass lenses. Hydrostatic testing can verify inner glass strength only, so the pressure rating is based on that strength.

A safer and more reliable sight flow indicator is achieved by using a single fused-glass sight glass. Because the metal frame holds the glass in compression, the glass will have more strength and safety than a dual- or double-glass design. If the fused-glass window is made with borosilicate glass, then it also will be more resistant to thermal shock. Moreover, because it has fewer components than a double-glass design, it is less costly and easier to maintain. ●

MIKE CURNUTTE is the director of business development at L.J. Star. He can be reached at Mcurnutte@ljstar.com.

Pressing System Aids Copper Recycling Plant

Piping installation method helps eliminate bottlenecks and leaks and meet capacity needs

By Kristen White, Viega

Koppers Performance Chemicals recycles copper-clad materials and scrap copper at its plant in Michigan. The company then delivers a copper powder to its plants in Tennessee and South Carolina, where it's turned into a product used to pressure-treat lumber. Copper is one of the major components used in pressure treating lumber to prevent rotting.

"We get all kinds of copper scraps, even the copper trinkets that you might get at a tourist place. If it's scrap, we'll take it," says Phil Sturos, project engineer with Koppers.

During the process, the copper slurry is de-watered through a pressure filter, creating a "copper cake" that is processed through a flash dryer and dust collector system. Sturos explains that the existing equipment was under capacity, causing a bottleneck at the end of the process.

Figure 1: Koppers Performance Chemicals had 2-in. Schedule 10 stainless steel pipe installed using Viega MegaPress Stainless 90° and 45° elbows, as well as tees.

COMPANY CHOOSES NEW APPROACH

To increase the plant's output capacity, additional de-watering and drying equipment was installed. After experiencing trouble with leaks using other pipe-joining methods, the company decided to give pressing a try when piping a section of its facility for the new installations. The company opted to install Viega's MegaPress Stainless piping to provide water for the plant's cooling process.

"We didn't want to thread the pipe, and welding was an option we looked at, but it's time-consuming," Sturos says. "We've also used grooved pipe fittings in the past here, too. Pressing was appealing because of the ease of installation. We were looking down the road for our maintenance guys, too, to use this product."

The company had approximately 600 feet of 2-in. Schedule 10 stainless steel pipe installed, connecting it with MegaPress Stainless 90° and 45° elbows, as well as tees. The new pipes went online in the fall, with production ramping up after that.

ADDITIONAL WORK

After a demo of pressing products, Koppers was ready to move forward with the MegaPress Stainless product. After it was installed successfully, Koppers considered more products. The company recently ran 1½-in. carbon steel lines, complete with MegaPress fittings, for an ammonia-based solution it uses.

Figure 2: After other pipe joining methods caused leaks, Koppers Performance Chemicals used pressing technology to pipe a section of its facility.

Koppers purchased a Ridgid press tool to have on hand at the plant. With so much existing piping at the location, having the tool there provides quick and easy access for maintenance or future work. ●

KRISTEN WHITE is content marketing editor at Viega. She can be reached at kristen.white@viega.us.

ADDITIONAL RESOURCES

EHANDBOOKS

Check out our vast library of past eHandbooks that offer a wealth of information on a single topic, aimed at providing best practices, key trends, developments and successful applications to help make your facilities as efficient, safe, environmentally friendly and economically competitive as possible.

UPCOMING AND ON DEMAND WEBINARS

Tap into expert knowledge. Chemical Processing editors and industry experts delve into hot topics challenging the chemical processing industry today while providing insights and practical guidance. Each of these free webinars feature a live Q&A session and lasts 60 minutes.

WHITE PAPERS

Check out our library of white papers covering myriad topics and offering valuable insight into products and solutions important to chemical processing professionals. From automation to fluid handling, separations technologies and utilities, this white paper library has it all.

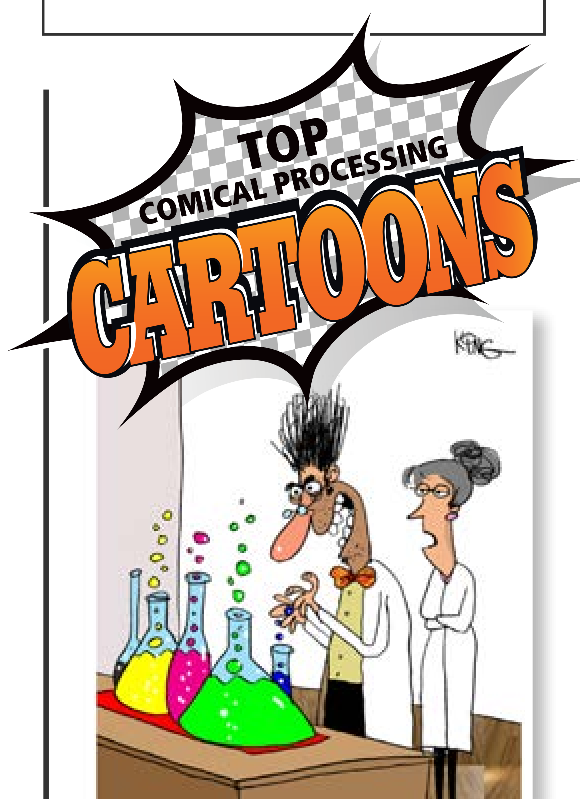
MINUTE CLINIC

Chemical Processing's Minute Clinic podcast series is designed to tackle one critical issue at a time — giving you hard-hitting information in just minutes.

ASK THE EXPERTS

Have a question on a technical issue that needs to be addressed? Visit our Ask the Experts forum. Covering topics from combustion to steam systems, our roster of leading subject matter experts, as well as other forum members, can help you tackle plant issues.

JOIN US ON SOCIAL MEDIA!



Visit the lighter side, featuring drawings by award-winning cartoonist Jerry King. Click on an image and you will arrive at a page with the winning caption and all submissions for that particular cartoon.