\# 164

QUESTIONS FOR TRAVELING SCREEN MANUFACTURERS
Received from Trent Gathright on 9/11/2002.

REPLACING COARSE MESH TRAVELING SCREENS WITH FINE MESH TRAVELING SCREENS

The following questions inquire about replacing coarse mesh traveling screens with fine mesh traveling screens. Note that replacement screens will have fish baskets for use with a return system. If you perform this kind of work, please answer the following questions:

The following questions cover the breadth of information being sought but admittedly are somewhat extensive. Those shown in non-bold print are generally require brief or quality responses and are intended to be discussed over the phone. **Questions in bold print may require research and may best be presented in a follow-up context.**

General

1. In consultations and/or projects, how often do you encounter site conditions at existing intakes where the existing screens cannot be readily accessed via crane?

   In approximately 25 years of experience, we see +/- 40 % of the Traveling Screens that are housed in buildings that require the dis-assembly of the screens prior to removal. Therefore, these are not "readily accessible" for immediate removal. This is of course a rough estimate.

2. What range of screen mesh opening sizes do you consider to be "fine mesh?" When facilities examine and/or select finer mesh to reduce entrainment, what is the most common mesh size? Are there any differences in the fine mesh sizes commonly evaluated and/or selected for new intakes versus existing intake retrofits?

   The old common "rule of thumb" for the mesh size of traveling screens is ½ the diameter of the condenser tube, therefore 97% of existing "Thru Flow" type traveling screens contain 3/8" square opening mesh. We consider anything between ½" to ¼" opening to be coarse mesh and 3/16" and smaller to be "fine" mesh. We have retrofitted a number of screens with 1/8" opening both on fish handling and none fish handling. I personally performed a number of experiments in 1983 to 1986 on the result of Fish as they encounter traveling band screens. This was the first work actually observing fish "underwater" through ports in the sides of the flume. The results conclude that "smooth" top mesh (woven wire mesh pressed flat on the upstream side to provide a smooth surface to prevent descaling) with a slotted opening typically 1/8" wide x ½" tall. Many screens with 3/8" and ¼" square openings are just large enough to allow juvenile fish to become lodged in the mesh opening. New intakes are typically retrofitted with 1/8" x ½" Smooth Top mesh if fish handling is required, (based on the work performed by Fletcher & Gathright).

3. What is the range and typical spacing between multiple screen units at most existing intakes? In other words how wide are the columns/walls at the screen location? How close can they be, if space limitation is an issue? How much of the well width does the screen panel cover?

Typical spacing between screens is normally +/- 2'-6" due to the civil works wall between adjacent cells. The screens overlap above deck by +/- 1'-0" thus allowing approx. 1'-6" between most Thru Flow Band Screens. Dual Flow Conversion screens eliminate this clearance problem. We will discuss this in greater detail later. The most common width channel is 11'-2" (although there are wider and narrower installations) thus allowing a 10'-0" effective width Thru Flow. The frame of the screen fits into guide slots embedded in the civil walls and contains the chain tracks. Each side frame absorbs approx. 7" thus the rule of thumb is that the effective width of a screen is normally 1'-2" less than the channel width.

4. How practical is it to replace screen panels only, versus replacing the entire mechanical unit? When finer mesh is required, how practical or common is it to replace screen panels only? What is the deciding factor? What are the relative cost savings compared to replacing the entire screen unit?

It is of course more practical to only replace the mesh unless it involves fish handling. The old method typically referred to as a "Ristroph" screen literally adds a bucket (like a house gutter) to the bottom lifting shelf of each basket (panel). However this method has been well proven that it SIGNIFICANTLY adds to fish mortality. The "bucket" not only absorbs mesh room but creates a vortex in the bucket that slams the juvenile fish against the mesh again and again eventually leading to mortality. We therefore created a NEW basket design that converts the structural cross members (i.e. basket rails) into a hydraulically stabilized area that actually attracts the juvenile fish as they get close the screen. The old method caused fish to avoid the screens due to the vortex in the bucket as all fish have an inherent "pressure sensitive live" that runs longitudinally along their body. Thus they react quickly to changes in pressure. The new method creates a sheltered zone that they seek and are therefore quickly removed form the intake. This new method is referred to as S.I.M.P.L.E.™ (Stabilized Integrated Marine Protective Lifting Environment) developed by this author and his associate engineer. Although a screen may be retro fitted, this would include all new baskets, extending the height of the head section to accommodated fish sprays, changing the housings to accommodate fish sprays and fish troughs, a larger drive to accommodate the unbalanced load, etc… therefore the only thing typically salvaged is the frame and head shaft or about 25% of the cost of a new screen. It is therefore recommended that NEW screens be installed vs. retro fitting.

5. Can wedge wire type screen panels be used on traveling screens?

Yes wedge wire can be used but this is cost prohibitive vs. using Smooth Top mesh. Wedge wire is about 3 times more expensive than regular mesh and 2 times more expensive than smooth top mesh.

6. What problems may be encountered in replacing coarse mesh with fine mesh traveling screens (either screen panel only or entire unit). What are the typical solutions? Specifically,

   -Problems with collection of additional debris?
   -Problems with increase in through screen velocity?
   -Other problems (describe)

   -Debris collection is actually increased although some minor problems are encountered with debris in the fish troughs if filamentatious algae is encountered.

   -The "Through screen velocity" can be reduced slightly with a Thru Flow type screen and often greatly with a Dual Flow Conversion screen. Both would utilize the S.I.M.P.L.E. basket that increases basket percent open area.

   -Typical solutions the replacement of the entire screens with a prior study of the most common debris encountered.

7. Can replacement of through flow with dual flow (double entry single exit) screens be used to increase screen area and thus reduce through screen velocities and reduce impingement?

   Yes. We have provided a number of Dual Flow Conversion Fish Handling Band Screens (Dunkirk, Medicine Hat, Barking Reach) to reduce velocity. The effective width of the screens can be increased as the panels (baskets) are parallel to the channel vs. perpendicular. Normally the deck opening parallel to the channel is only +/- 5'-4" but the deck is typically a concrete walk way only about 1'-0" thick and can be easily removed by cutting to allow for a DFC.

8. What is the % open space for typical coarse mesh traveling screens (e.g., 3/8 inch) that were evaluated and/or installed at power plant intakes in the past? If not known, what is a typical wire gauge? **What is the % open space for different sized fine mesh screens?**

   Typically 67.9 percent open area (opening)^2 / (opening + wire dia.)^2. The most common is 3/8" square with 14 Ga. (0.080" diameter wire).

9. Are you aware of any recent retrofit installations where the system capacity or flow volume was not increased, yet substantial civil/structural modifications were necessary?

   If so: NO, not on retro fits. The only reductions we have seen are on new installations where the velocity is limited.

   -What was done and why?
   -What was the facility name and location?
   -What were costs or who can we contact for cost information?

Equipment Costs

10. EPA previously obtained 1999 costs for single entry single exit traveling screens with the structural component made of carbon steel coated with epoxy paint and screens made of 304 stainless steel, with non-metallic baskets. Can you provide delivered equipment costs for comparable (freshwater) fine mesh (using most common mesh size from above) screen units with widths in the range of 5, 10, 14 - 15 ft and well depths in the range of 10, 25, 50, 75, & 100ft?

The 1999 traveling screen costs included:

-Non-metallic fish handling panels
-Spray systems
-Fish trough
-Housings and transitions
-Continuous operating features
-Drive unit
-Frame seals
-Engineering

Budget Prices for Fish Handling Thru Flow Band Screens

Application: Fresh Water (Primarily Epoxy Coated Carbon Steel with Stainless Steel Mesh and Fasteners)

	Effective Width (ft.)		
Depth (ft)	5'-0"	10'-0"	14'-0"
10	$ 69,648	$ 87,453	$ 100,732
Approx. HP	3/4	1	3
20	$ 89,028	$ 109,202	$ 123,622
Approx. HP	1	2	5
30	$ 108,408	$ 135,251	$ 166,961
Approx. HP	2	5	7.5
40	$ 127,788	$ 153,688	$ 178,154
Approx. HP	3	7.5	10
50	$ 151,500	$ 222,853	$ 249,921
Approx. HP	5	10	15
60	$ 170,880	$ 256,415	$ 290,556
Approx. HP	7.5	15	20

Budget Prices for Fish Handling Thru Flow Band Screens				
Application: Brackish Water (Primarily 316 Stainless Steel with Stainless Steel Mesh and Fasteners)				
	Effective Width (ft.)			
Depth (ft)	5'-0"	10'-0"	14'-0"	
10	$ 137,903	$ 182,226	$ 213,436	
20	$ 176,275	$ 227,544	$ 261,937	
30	$ 214,648	$ 281,822	$ 353,765	
40	$ 253,020	$ 320,239	$ 377,482	
50	$ 299,970	$ 464,359	$ 529,547	
60	$ 338,342	$ 534,291	$ 615,647	

If we are unable to obtain updated costs we may use the ENR Construction Cost Index which results in a capital cost increase of 9% when updating 1999 costs to July 2002. Do you feel that this reasonably reflects the actual changes over this period?

Yes as we normally use an inflation rate of 2.5% so 3% over 3 years is a good number.

11. What equipment materials do you recommend (or are commonly selected) for corrosive environments, such as brackish and saltwater? What is the most common material selected for saltwater environments?

-Carbon Steel with epoxy coating (freshwater) This is also very common for sea water with sacrificial zinc anodes for the frames and even the basket frames.

-304 Stainless Steel – Never for brackish as 304 does not stand up to chlorides.

-316 Stainless Steel - Most of the plate material is now dual certified as 316L, which is used to prevent crevice crack corrosion from the carbides that would normally surface with plain 316. Of course the non welded items such as the mesh and fasteners would be 316SS.

-70/30 Copper Nickel – Once in 25 years for an Alaskan project.

-90/10 Copper Nickel-Very rarely.

-Other (Describe)- For warm seawater (i.e. countries closer to the equator) it now common to see requirements for 316Ti (316 with Titanium) as well as 317 SS.

12. Can you provide equipment costs of this corrosion resistant equipment or provide relative equipment cost difference compared to freshwater unit, such as a cost factor or percent increase?

See the above chart for brackish / seawater applications.

13. What water bodies are experiencing problems with Zebra mussels and how much extra are the equipment costs for special alloy construction or comparable materials?

Zebra mussels are fresh water mollusks that came over from Russia ships and were discharged into the Great Lakes via the ships bilge water. These are now common in every water body that connects to the Great Lakes. They do not like warm temperatures yet but they are adapting and moving down the Mississippi. There are paints with musselcides (i.e. copper based paints) that supposedly will kill mussels but they last so long before being rendered ineffective. This is too general of a question to give you a quantitative answer. We suggest incorporating debris filters just upstream of the condensers to prevent macro-fouling as mussel larvae are to fine to screen out at the raw water intake.

14. **If you indicated replacing screen panels only is practical, can you provide estimates of the costs for replacing the panels only, including both equipment and installation?**
NOT only is this not practical it would also not be functional.

15. **Please provide a description of installation methods and typical costs for screen units, and whether you perform such services including differences for wet versus dry installation. Also discuss relative cost of removal and disposal of existing screens (are the costs minimal?).**

Can you provide us with a list of benefits that Brackett Green will receive for providing this information free of charge ?

Screen change out varies from site to site based on the screen effective width, depth, is it in door or out door, how close can you get a crane, does it have to come out in pieces, etc…but at the end of the day the average, typical, cost for removing the old screen and installing a new screen is +/- $ 45,000 per channel (or per well).

16. Are there any special considerations for nuclear facilities (e.g., does screen framing need to be stronger and more resistant to collapse) and how do the special considerations affect equipment selection, costs and/or performance? Are there any other situations where similar requirements are common? **Can you provide an equipment cost factor for selecting screens that meet these requirements versus typical non-nuclear installations?**

Nuclear sites can vary from what is termed as "C" class or Commercial class, which are normal screens for an intake that is not seismically qualified. When "Q" class screens are required for seismically qualified intakes, the screen price can be as much as 50% more just because of the Quality control required for tractability.

17. Would converting to fine mesh screens have a significant effect on O&M costs? If so how much and why?

Yes it would have an impact as the screens would most likely operate under a higher differential thereby wearing out the chain quicker.

Construction Duration

18. When replacing existing screen units (or screen panels only), approximately how long would the intake bay and/or pumping unit need to be shut down?

In theory only 1-3days but in actuality this would normally have to be done during an outage to accommodate the new troughing, piping, etc… so we would suggest a 2 week turnaround depending on if old screens had to be removed.

Testing

19. Once the new screens are installed, what kind of performance testing is typically required? Is this often part of the package if you perform installation? **What are typical costs and how do these costs compare to other construction/equipment costs? What factors affect the costs?**

The answer to this depends on whether you are referring to performance of fish recovery or just screen operability. Normally a fish screen has to be reviewed for one year to properly account for all of the indigenous species migrating past the intake.

Testing the screens for operability after installation is often in our package but normally only consists of 1 to 3 days of field service to make recommendations on adjusting the sprays, leveling the head shaft, checking gaskets, etc…

ADDING FISH HANDLING AND RETURN

The following questions inquire about adding a fish handling and return system to an intake with traveling screens where no fish return existed before. This can involve either retrofitting existing screens with fish handling features or putting in new screening units. In either case, the questions also focus on the costs and technical aspects of the addition of a fish return sluice/conduit (and possibly fish pumps).

20. Do you sell fish return retrofit systems for existing traveling screens? Yes. Can most existing screens be retrofitted without replacing the entire unit? No, most cannot but some can. We would estimate that maybe 30% of existing sites could upgrade without replacing the entire unit. Many sites could all into this but it is economically logical to do this as the parts and modifications required approach 60 to 70% of the cost of a new machine, then enter the warranty issue into the picture and most clients opt for a new screen. When is it more practical/economical to replace the whole screening unit? **70% of the time.** **What are the costs for adding fish buckets, spray systems and troughs either in**

relation to other costs cited or for equipment sizes described earlier? 35-40 %. **How much would the addition of fish buckets only reduce cost over replacing entire screen unit? Not acceptable.**

21. How do you determine the design flow volume for the fish return conduit? Based on velocity. Generally, what proportion of the intake flow is diverted to the fish return? Impossible to quantify as the same width machine would require the same fish spray water but the depth could be 2 to 3 times greater.

22. **Do you design, provide, or install fish return equipment such as pumps and return conduit? We can supply the fish return troughs.**
    If so:
    -How are the return pipes/flume configured and sized? Per site.
    -Is there a minimum diameter to accommodate large fish? Large fish are not the object but the pipe must handle the water volume.
    -What are typical slopes and velocities? 1/16" per foot to 1/8" per foot. Velocity can be state specific based on getting the fish out of the trough.
    -If pipes are used, do they tend to flow full? No.
    -What materials of construction are used for fish return conduits (fiberglass)? Fiberglass.

23. EPA Survey data show few existing traveling screen return systems use fish pumps. Under what circumstances would fish pumps be necessary? Would not recommend them.

24. **Do you have any cost data to share for adding fish return systems, especially fish pumps and return conduits? In general, what are typical equipment and installation unit costs for the conduit and support structure for return flows associated with intakes with capacities of 5,000 GPM to 500,000 GPM? If not available, who should we contact for more information? Fish return systems would run +/- $ 25,000 depending on how many screens and how far they had to discharge.**

25. What is the typical range of return conduit lengths? 75 to 150 feet. How does water body type influence return conduit length? If it is tidal, it must discharge both directions. For example, do lengths tend to be shorter for non-tidal rivers and streams? Longer.

26. Would there be any difference in intake downtime when adding fish handling features compared to downtime for screen replacement? Yes because of the additional piping, controls, troughs, etc… for the fish handling screens. For normal screen replacement, we have done these in as little as 12 hours each.

27. What additional O&M cost would be associated with a fish return system besides the operation of the screens? Fish spray wash water only as it is really a passive conduit.

28. The total average water required for a fish screen including the debris spray, inside fish spray, outside fish spray and trough make up water is **74.5 GPM per foot of effective width. (not the 40 to 50 quoted during our telecon).**