Evaluating Mechanical / Hydraulic Governor Systems and Supportability Options

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ABSTRACT

It can be a challenge to determine the right approach to maintaining the existing mechanical equipment for a turbine governor system. In many cases, the original equipment OEM is no longer in business or is not readily available to support the mechanical equipment.

This paper presents two case studies related to maintaining existing mechanical governors and refurbishing two mechanical governor-distributing valves to optimize the systems’ digital governor upgrades. The refurbished distributing valves were retained while the rest of the governor was upgraded to digital. In both of these cases, the mechanical governors were obsolete and support from the original vendor was not available.

The intent of these case studies is to provide the reader with insight into how to assess a mechanical governor system and provide an overview of what options are available for supporting an existing mechanical governor system. The case studies also show the process that was used to refurbish an existing mechanical governor-distributing valve and what can be done to optimize the valve for use with a digital governor system.

Specific Areas of Discussion:

- Assessing governor hydraulic systems
- Assessing mechanical governors
- Distributing valve retrofit and support options
- Optimization of existing distributing valves for use with digital governors
Introduction

If you are a hydro turbine governor owner, you know that at some point you will be faced with the difficult decision of deciding whether to support the mechanical / hydraulic systems that are part of your governor system or replacing them. The decision is not simple and merits analysis of each possible solution.

In some cases, you may see the most return on investment if you keep the mechanical governor or existing hydraulic system with a plan to procure the right parts. In other cases, the right approach may be to replace the entire governor system, even if it costs more.

The following case studies provide an overview of two projects where the existing mechanical systems were maintained. In the first case, the end user opted to retain the mechanical governor for the historical value, and the distributing valves were refurbished and optimized to operate with a digital governor. In the second case, an assessment of an existing mechanical flyball governor was performed with the intent of creating a support plan to maintain the mechanical governor into the future.
CASE STUDY #1 – Retrofit of English Electric Distributing Valves

The following case study involves a refurbishment of two different mechanical English Electric governor systems that were installed in the late 1950s. OEM support for the English Electric governor systems is no longer available, however, in this case, the end user did have access to dimensional drawings of the existing governor systems.

The original governor systems were in good working condition. The governors were being upgraded to digital as part of the client’s ongoing work to refurbish the turbine / generator. Originally, the end user intended to make new distributing valve components using the original dimensional drawings. The replacement bushing and plunger assemblies would be designed as exact replacements of the existing. As part of this work, they were also modifying the original pilot valve interface to add a digital control interface on each of the mechanical governor systems. Note that the dimensioned parts drawings are typically not available to the end user because the governor manufacturers did not provide these as part of the project.

As part of their process to determine how to approach this project, the end user considered the following options:

1) Replace entire governor system with a new high pressure system.
   • This would have also required the replacement of the wicket gate servomotors.

2) Remove the existing mechanical governor and replace it with a new distributing valve while retaining the existing servos.

3) Retain the existing distributing valve and update the internal parts.

While deciding how to approach this project, they decided to retain the existing distributing valve and update the internal parts after they considered the following:

1) The removal / installation cost associated with replacing the mechanical governor system with a new distributing valve was more than they wanted to budget for the governor rehabilitation.

2) The end user placed a high value on the historical look/feel of their plants. As a result, they did not want the new governor to “look like a retrofit.”
   • A new distributing valve would have required extensive piping reconfiguration due to the size difference between the piping connections on the new valve and the size of the existing ports.
The two governor systems that were updated are shown in the images below.

Figure 1: Original English Electric Mechanical Governors

This project started with a review of the existing governor systems and a detailed review of the original parts that were to be replaced. In each of the original governors, the distributing valve sleeve was made of bronze and the spool was made from cast iron. The materials provided many years of reliable service, however, modern materials are available that have higher tensile strengths and self-lubricating abilities. The image to the right in Figure 1 shows an overview of the governor system seen on the left.

The sleeve / bushing and the spool were to be replaced with new parts. In addition, the mechanical governor section would be removed and blanked off to maintain the overall look of the governor. A new control manifold interface was designed to replace the mechanical pilot valve. This modification was designed into the replacement parts so that the new configuration was clean and easy to maintain.
As with any retrofit project, there were risks that had to be identified and mitigated. They were as follows:

1) Detailed measurements were not available for the bore of the existing valve cases. These measurements would not be available until the mechanical governor was removed from service for the upgrade.
   - The risk was that even though the dimension drawings were available, it was not guaranteed that the existing parts were built to the drawings. A common process for the manufacture of distributing valves was to machine the ID (inside diameter) of the valve case and then if the case did not meet the tolerances on the drawing, the sleeve OD (outside diameter) could be machined to match. At the time these valves were originally manufactured, grinding the OD of the valve sleeve was much easier than machining the ID of the valve body.

2) The timing adjustments were being moved from orifices in the piping to hard spool stops built into the distributing valves.
   - The risk was that the system was not designed for the valves to be used as the main flow restriction for the timing.

3) Existing governors had very short distributing valve strokes of less than 0.2” from full-open to full-close travel.
   - Dynamically, this results in a large gain step around the null point of the valve, which can lead to an unstable valve when used with a digital control system (governor).

4) The manufacturing of the valve components was a risk due to the size of the large sleeve. In addition, the schedule was a concern because the difficulties related to machining the parts were not factored into the original project.
   - The size of the sleeve (9.0” ID x 28” length) was larger than most machine shops could handle with their current equipment, while meeting the precise dimensional tolerances that were required.

The risks were addressed during the review / detailed design phase as follows:

1) To mitigate the risk of designing parts to fit into an existing valve body, the OD of the sleeve for each governor was left slightly oversized. Time was built into the overall schedule to take detailed measurements of the existing valve body and to finish grinding the OD of the sleeve to match the ID of the valve body.
   - Adding this step to the installation process proved to be necessary because when the valve was disassembled, the bore was found to be out of tolerance. The original parts were machined to fit the bore of the valve body and new parts built to the drawing would not have fit the existing valve body.

2) CFD analysis was performed on the new bushing and plunger to verify the flow capability and expected pressure drops.
   - This step was invaluable because it was found that on the smaller governor, the primary restriction for the closing timing was the distributing valve spool assembly. This restriction was designed out of the system by increasing the size of the internal flow passage while keeping the same safety margins as the original system. The figure below shows the closing passage and the final expected pressure drops as shown by the CFD analysis. The yellow indicates that the final pressure drop was higher than desired, however, it still met the system requirements.
3) CFD was used to optimize the flow gain around the null point and also to optimize the total valve stroke. The CFD enabled an analysis that allowed the stability margins to be maximized around the null point of the valve while minimizing the full stroke travel of the spool. A traditional design would have increased the valve travel, however, in this case, that was not possible due to the shutdown requirements.

4) The manufacturing risk mitigated was related to project schedule and the material used for the new parts. The end user procured the raw material to make a new spool and sleeve locally in the event that they ran into a problem during the installation / commissioning phase of the project. The material used was not readily available on the world market, so a set of raw material was shipped to the site with the machined parts.
   - This mitigation also met the requirement for spare parts. Because the three units of each type were machined to fit the individual governors, it was possible to stock a single set of spare parts. Spare capability was provided by stocking the raw material to make the parts at the site.

The following is a summary of the optimizations / modernizations made to the distributing valve:

1) Updated the materials from bronze and cast iron to modern materials that have self-lubricating characteristics and higher tensile strengths.

2) 100% sealed design to eliminate oil leaks.

3) Removed excess material where possible to reduce the overall weight. For example, on the spool, the webs for the control lands were machined out to reduce the overall weight of the spool by 34% (~ 70 pounds). This improved the dynamic response of the valve and also improved the serviceability by making the parts easier to assemble.

4) Optimized the control piston area and control volumes to improve the dynamic response while maintaining adequate force margins.

5) Reduced the overall number of parts by redesigning the timing adjustments, control manifold interface, and redesign of the control pistons.
6) Produced parts to be self-aligning to simplify assembly.
   - The assembled "kit" for the large governor weighed more than 650 pounds. Aligning parts of this size that have tolerances of less than .0005" would be very difficult without a self-aligning design.

7) Redesigned the timing stops and increased the resolution of the timing adjustments to provide a repeatable / easy-to-adjust timing system.

8) Improved distributing valve flow turn-down to allow smooth transitions from zero flow to open/close flow.

9) Further optimized the porting to minimize the time required to for the valve to slew from full-opening porting to closing porting in the event a shutdown occurs while the unit is ramping the wickets gates open.

10) Optimized valve overall lap to minimize internal leakage while still providing a system that met IEEE / IEC deadband and deadtime requirements.

The final design for the large governor with a 9" diameter spool is shown below for reference.

Figure 3: Large English Electric Distributing Valve Refurbishment "Kit"
The refurbished governor systems are shown in the figure below. In both cases, the entire mechanical governor was retained, however, only the distributing valve is actually still in service. An additional modification that was not part of the distributing valve retrofit was to add the stand pipe to the drain of the governor to maintain a constant back pressure on the valve drain connection. This required the final valve design to be completely sealed and capable of operation with a pressurized drain. The original designs would not have worked.

![Figure 4: Final Governor Design with Drain Chamber](image)

The takeaways from the English Electric valve upgrades are:

1) It is possible to upgrade existing hydro governor distributing valves to provide a modern design, optimize the dynamics for a digital governor, and reduce maintenance without the support of the OEM.

2) Detailed machining drawings were helpful, however, due to the machining capability at the time that the original equipment was designed, parts designed to original drawings may not be a drop-in replacement. Detailed measurements of the existing equipment are required. Be sure to document each of the systems as they are completed!

3) If any part of the system is changed, do not assume that the existing components will work with the new system. In this case, the orifices in the piping were not actually controlling the closing time; the timing restriction was internal to the original spool. This issue would not have been discovered until the timing was set during the commissioning. In this case, this would have resulted in a long delay in the project or running the unit with incorrect closing gate timing.

4) Not all projects would require the level of detail that went into the analysis of this redesign project. Each project is unique, and the risk associated with the project must be evaluated on a project-by-project basis.

5) It is possible to retain the historic look and feel of the original governor and also have a modern design that is optimized for a digital governor. In this specific case, because there were three of each type of English Electric governor, the engineering / parts costs and the costs to do the final machining in a local machine shop was still less than the estimated cost of retrofitting the system to use a new distributing valve.
CASE STUDY #2 – Mechanical Governor Assessment

The following case study looks at an assessment of an existing mechanical governor where the end user wanted to maintain the mechanical governor instead of retrofitting to a digital governor. The end user had decided against a digital retrofit due to the high cost and the fact that their operations staff was comfortable operating and maintaining their existing Pelton governors.

![Existing Pelton Mechanical Governor](image)

*Figure 5: Existing Pelton Mechanical Governor*

A challenge that they were working to overcome was how to maintain their governors when OEM support is no longer available. The story of Pelton is similar to many of the mechanical governor manufacturers where the company merged with BLH (Baldwin Lima Hamilton), then was bought by Greyhound in the early 1960s. In the early 1970s, the Pelton Water Wheel Governor assets were sold to Cheston. This story of companies changing hands is very common in the hydro electric industry.

For their mechanical governors, the end user decided that their first step was to perform an assessment of the existing governor systems. The assessment involved a complete disassembly, cleaning / inspection of all parts, and assembly / calibration of the mechanical governors. The output of the assessment was a ranking (priority) of the various systems, support options to be considered, and a budgetary cost associated with the support options. This case study walks through the assessment and provides an overview of the various considerations.
The main systems of the mechanical governor are:

1) Hydraulic system consisting of the pumps, unloaders, relief valves, pressure tank, and air charging system.

2) Governor-distributing valve.

3) Mechanical governor system consisting of the pilot valve, gate limit, dashpot, flyballs, shutdown solenoids, setpoint adjustments, and indicators.

4) Wicket gate servomotor.

Hydraulic System Assessment

The hydraulic pressure system was tested to check the operation of the pumps and unloaders, and to record operating parameters as shown in the table below.

<table>
<thead>
<tr>
<th>Control Mode</th>
<th>Pump Output</th>
<th>Pre-evaluation Oil Usage</th>
<th>Governor Mode</th>
<th>Governor Mode</th>
<th>Manual Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shutdown Solenoid</td>
<td>SD Dropped</td>
<td>RESET - RUN</td>
<td>RESET-RUN</td>
<td>SD Dropped</td>
<td></td>
</tr>
<tr>
<td>Start Pressure (psig)</td>
<td>260</td>
<td>260</td>
<td>260</td>
<td></td>
<td></td>
</tr>
<tr>
<td>End Pressure (psig)</td>
<td>290</td>
<td>295</td>
<td>295</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Start Level (inches)</td>
<td>33.5</td>
<td>37.25</td>
<td>37.25</td>
<td>37.25</td>
<td>35.5</td>
</tr>
<tr>
<td>End Level (inches)</td>
<td>36.25</td>
<td>34</td>
<td>34</td>
<td>34</td>
<td>34.5</td>
</tr>
<tr>
<td>Time (MIN:SEC)</td>
<td>17</td>
<td>2.52</td>
<td>3:10</td>
<td>4.24</td>
<td>10:45</td>
</tr>
<tr>
<td>Time (seconds)</td>
<td>17</td>
<td>172</td>
<td>190</td>
<td>264</td>
<td>618</td>
</tr>
<tr>
<td>Delta Oil Volume (in^3)</td>
<td>1784.25</td>
<td>2109.84</td>
<td>2109.84</td>
<td>2109.84</td>
<td>649.18</td>
</tr>
<tr>
<td>Delta Oil volume (gallon)</td>
<td>7.73</td>
<td>9.13</td>
<td>9.13</td>
<td>9.13</td>
<td>2.81</td>
</tr>
<tr>
<td>GPM</td>
<td>27.28</td>
<td>3.19</td>
<td>2.88</td>
<td>2.08</td>
<td>0.27</td>
</tr>
</tbody>
</table>

Figure 6: Hydraulic System Assessment Test Data

For this system, the hydraulic schematic was reviewed, and it was determined that the five tests shown in the pressure system data table would provide an indication of the operating state of the mechanical governor. The reasoning behind the test cases was:

**Pump output** - This test recorded the volumetric output of the governor oil pump with the unit in a shutdown state. In the shutdown state, the gate limit valve physically blocks the control oil, which results in a lower oil usage. The pressure tank level was used to determine the volume of oil that was output by the pump. The pump runtime was recorded and used to determine the pump output. Note that the pump runtime was recorded based on the actual loaded operation of the pump. The pump output was not compensated for the governor oil consumption during this same time period.
**Pre-Evaluation Oil Usage** - This is the "as found" steady state oil consumption, which was recorded with the governor in the running state. In the running state, the shutdown solenoid is energized and gate position is determined by the gate limit. The turbine was not rotating during this test.

**Governor Mode – Gate Limit=0** - After the inspection / maintenance, the pre-evaluation oil usage test was repeated to provide a comparison. In this case, the oil usage rate was reduced by almost .5 GPM. This was expected as the governor oil pump check valve was suspected to be bypassing oil when the pump was running.

**Governor Mode – SD Dropped** - When this governor system is in the shutdown position (shutdown solenoid de-energized) a spool valve is positioned to block the control oil flow to the governor flyball assembly. This state should have a much lower oil usage than the running position. The test showed a reduction in oil flow of ~30%. This was less of a reduction than was expected. The results from the manual mode test indicate that the majority of the oil usage is due to oil bypassing in the distributing valve.

**Manual Mode** - In manual mode, the governor-distributing valve is completely isolated from the servo by integral isolation valves. The significant reduction in the oil usage indicates that the majority of the oil consumption is due to the leakage in the distributing valve.

The tests referenced above can be performed during the annual maintenance cycle to provide a reference point for governor internal leakage.
Pumps and Unloader Assembly

The existing hydraulic pump is fully supportable from the pump OEM (Original Equipment Manufacturer). Seals and rebuild kits are available for the IMO screw pumps. This enables the end user to maintain the pumps as part of their standard maintenance program.

The assessment of the pump unloader and relief valve was done through disassembly and inspection. The pump unloader consisted of a mechanical unloader that utilizes a “snap action” pilot valve assembly. This assembly controls the loading and unloading of the pump to maintain the hydraulic system pressure. The disassembled unloader assembly is shown in the following figure.

![Unloader / Relief Valve Assembly](image)

*Figure 7: Unload / Relief Valve Assembly*
The condition of each part was assessed. The assessment criteria for this assembly was:

- Parts inspected for normal wear or damage.
- Relief valve and unloader cartridge seat inspected for uneven seating / wear due to oil flow. Seating surfaces on the relief valve and unloader cartridge can be lapped using a fine lapping compound to restore the seats.
- Springs and O-rings were measured and documented to enable the purchase of replacements.

A consideration for the unloader assembly is that the mechanical pilot valve assembly can be replaced with a solenoid operated assembly, which would eliminate the mechanical pilot valve and replace it with an off-the-shelf solenoid valve / pressure switch.

The check valve was also removed and inspected, and the seat was re-lapped to prevent any leakage under normal operation.

For this specific system, the check valve is integral to the existing unloader casting. The actual seat is a separate piece that is pressed into the case. From a support standpoint, the check valve is fully supportable because the seat can be replaced, and new parts can be made to replace the check valve cartridge and the check valve cover. The check valve spring can also be replaced by measuring the existing spring and having a new one made by a spring fabricator.

The unloader control oil filter assembly was inspected but not disassembled. The filter assembly is a 40 micron strainer, which could be replaced with a filter assembly to extend the life of the unloader piston and pilot valve.

*Figure 8: Unloader Check Valve*
**Governor Distributing Valve**

The governor-distributing valve is a key part of the governor system. The distributing valve is integral to the overall operation of the governor whether it is digital or fully mechanical.

In this case study, the distributing valve was disassembled, inspected, and the integral manual isolation valves were reworked to restore the manual governor function. The manual isolation valves did not fully isolate the distributing valve when the manual mode was enabled. This prevented the manual function from working. As part of the assessment, the isolation valves were removed, cleaned, and tested to ensure that the valves moved freely. The distributing valve (relay valve) is shown in the figure below.

![Governor-Distributing Valve](image)

*Figure 9: Governor-Distributing Valve*
The key components for the distributing valve are the bushing and spool. These two parts are critical to the control of the wicket servomotor.

![Figure 10: Governor-Distributing Valve Bushing and Spool](image)

The bushing and spool are shown above. Both were found to be in good condition, and if the governor oil is kept clean, should have many years of service left. The key assessment parameter is that the edges are sharp on the spool and that the bushing is not scored. In this example, there are marks on the bushing where the spool is normally positioned to regulate the control oil to the wicket gate servomotor.

These marks were surface marks only and no material had been removed from the bushing (damage). Before installing the parts, the lands on the spool were polished with a hard Arkansas stone.

In the following figures, an example from a different version of the same manufacturer’s mechanical governor is shown. In this example, there is fretting on the control shaft where the shaft passes through the top cover. This fretting will continue to evolve, and part of the support strategy should be to create spares for these parts. A consideration would be to modernize these parts in a way that would eliminate the potential for the fretting and still allow the parts to be used with the existing mechanical parts and a future digital retrofit if desired.

As part of the assessment, these areas were stoned with a hard Arkansas stone until the shaft was again smooth and the parts were put back into service. Note that a “hard Arkansas stone” is off-white in color and has an approximate grit of 800 to 1000, which is ideal for polishing the lands on a distributing valve spool, the ID /OD of the sleeve, or the control shaft. An equivalent Japanese water stone would have a grit of 4000.
Figure 11: Governor-Distributing Valve with Shaft Fretting

For long-term support, a spare or replacement bushing / spool assembly could be manufactured. To do this, the bore of the distributing valve casing would need to be accurately measured to define the requirements for the OD of the replacement parts. The new parts would be designed as a set, which would be a direct replacement for the existing and could fit into the existing valve body. However, it would not need to be identical to the existing. As discussed in the first case study, these parts could be made with modern materials and tolerances to improve the performance of this governor system.

The mechanical governor components were assessed in detail because the intent was to maintain the mechanical governor in its entirety. The mechanical governor system consists of the governor ballhead, pilot valve, gate limit valve, dashpot, distributing valve intermediate feedback, and the associated links / levers. As part of the assessment these parts were disassembled, inspected and cleaned. The main systems associated with the
mechanical governor section are shown in Figure 12.

The key assessment parameters for each system is detailed in the following section.

**Dashpot** - The function of the dashpot is to temporarily modify the governor setpoint when the gates are moving. The dashpot provides a compensation function that keeps the governor from over responding to a setpoint / speed change. The compensation is required to stabilize the governor due to the long lag associated with time it takes the water column to change velocity in response to a new wicket gate position.

The key assessment parameters for a dashpot are:

- Verify that the pins and levers are free and there is minimal lost motion.
- Dashpot plungers should be free, and the shaft bushings should not be worn to allow excessive movement or binding.
- The dashpot plungers should be free to slide vertically in the dashpot case / bushings.
- The main assessment of the dashpot is functional. The dashpot reset time must be able to be set for the original specification. The reset time is the determined by how fast the dashpot small plunger re-centers after a gate movement.
- The dashpot oil should be kept clean and immediately changed if it is discolored.
**Pilot Valve and Gate Limit** - The pilot valve and the associated linkages are the main summing points of the governor system. The pilot valve is positioned directly by the ball head assembly (unit speed) and the position of the pilot valve floating lever pivot points. These pivot points are controlled by the dashpot (compensation, speed adjustment (setpoint), wicket gate feedback / droop cam, and the distributing valve spool position (inner loop feedback).

The key assessment parameters for a pilot valve are:

- Verify that the pins and levers are free and there is minimal lost motion. Note that on this specific system, there is a loading spring that keeps the lost motion to a minimum.

- Pilot valve should be free to move inside the pilot valve cage (bushing).

- Pilot valve / cage should not be excessively worn so that there is an increased steady state oil consumption during steady state operation.

- Gate limit valve should be free and all linkages checked for lost motion.

Note that if the pilot valve and cage are replaceable as a set, this makes it easier to support long-term, because the critical dimensions can be restored by designing a replacement pilot valve assembly. For this specific system both the pilot valve and the gate limit valve do not have replaceable cages. In this case, the ballhead could be machined to an oversized bore and a new oversized pilot valve / gate limit valve could be provided to restore the system to “new” tolerances. Reference Figure 13 for more details on this specific design.

![Figure 13: Governor Pilot Valve and Gate Limit Valve](image)

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Other systems that were part of the assessment were:

- Ballhead Motor - Supportable using off-the-shelf bearings. In this case, the end user used the numbers off the original bearings and cross referenced them to a bearing that was readily available.

- Permanent Magnet Generator – Located on top of the generator. The end user is able to fully support this with off-the-shelf bearings and spare parts that they had purchased when the unit was installed.

**Parts Availability**

As a final part of the assessment project, parts sources were identified. In most cases, where the OEM is no longer in business or providing parts, there are two sources for replacements. The first source is to reverse engineer the parts based on measurements taken from the original parts. This is an effective solution, however, it can be expensive due to the time required to create the detailed machining drawings. Reverse engineering becomes more cost effective if multiple units have the same parts.

Refurbished parts are also a potential option, however, the caveat with refurbished parts is that they have typically been removed from service and may not be a long-term solution. In the case of this assessment project, refurbished parts had been purchased to have spares for the pilot valve and cage on a different version of the mechanical governor. During the assessment, the pilot valve on the governor was found to stick in its null position. This caused erratic offline control and a deadband in the online load control.

The refurbished parts were installed and found to resolve the immediate problem, however, they were in worse condition than the original parts. The refurbished parts worked in this case because the ridge that was created by the rotating pilot valve had been honed smooth using a standard stone hone. This process was identifiable due to the characteristic cross hatch pattern that was left on the ID of the cage. As part of the honing process, several thousandths of an inch of material was taken off the ID of the cage in the area of the ridges. This resulted in a refurbished cage that no longer has a consistent diameter from top to bottom, which can also cause the pilot valve to stick.

![Refurbished Pilot Valve & Cage Assembly](image1)

**Figure 14**: Refurbished Parts Purchased as Spares
The refurbished pilot valve parts that were purchased as spares are shown in Figure 14. Even though the cage had been honed, the same wear pattern was observed on the ID of the cage.

In this case, the refurbished parts provided a short-term fix to the immediate problem, however, were in worse condition than the original parts.

An option that the end user could consider for long-term support is to have the pilot valve cage properly honed to a consistent internal diameter with a tight tolerance on the surface finish. An oversized pilot valve can then be machined to fit into the oversized bore in the pilot valve cage. This approach would result in a “like new” set of parts restored to original tolerances. Restoring the parts to like new condition could enable the parts to provide another 10 to 20 years of reliable service.
The takeaways from the mechanical governor assessment are:

1) Mechanical governors can be supported without support from the original OEM. Most bearings, springs, and seals can be procured through commercial sources. Note that finding a supplier who makes an equivalent part can be time consuming. Utilize local resources like bearing supply companies, hydraulic companies, etc.

2) The distributing valve is a key component and can last for many years. Contaminated oil is the main cause of problems. The second most common issue with distributing valves is alignment. The distributing valve can be reused if a digital replacement of the mechanical speed governor is done.

3) The governor oil pump is a key component that should last for many years with routine maintenance. Very few governor manufacturers made their own pumps. Generally, it is possible to find repair parts or replacement parts for the existing oil pumps. OEM parts for IMO and other major pump manufacturers are generally still available.

4) The pump unloader assembly is typically a custom part. The existing unloader can be supported with a combination of re-engineering of replacement parts and converting the mechanical snap action pilot valve to a modern solenoid valve with a pressure switch.

5) Refurbished parts can provide a short-term fix to a problem. The caveat is to make sure that it is clear what “refurbished” means. It may only mean that the parts were cleaned and polished after they were removed from service. In case study, the refurbished parts were actually in worse condition than the parts that were in the original governor. The refurbished parts provided a short-term fix due to the fact that the internal bore was honed smooth using a stone-type hone.

6) If the schedule allows the unit to be offline for a longer period of time, the original parts could be reconditioned / restored to like new condition. The process to do this is similar to repairing an engine where the cylinder sleeve is bored to oversize and then an oversize part (pilot valve) is machined to fit into the oversized bore. For governors, the challenge is meeting the required tolerances on the OD of the pilot valve, however, most precision machine shops could do this today.

7) Oil cleanliness is key to reliable governor operation.
Conclusion

Two case studies were reviewed to provide insight into options for refurbishing the distributing valves for mechanical governor systems that were converted to digital and maintaining an existing mechanical governor system.

The case studies were written with the intention to provide the reader with insight into two different project approaches and the process used to make the projects successful.

References


Biographies

James Volk, P.E., PMP – VP of Engineering at SEGRITY LLC

James has over 25 years of experience developing and maintaining mechanical, analog, and digital turbine governors in hydroelectric plants. He is the founder and VP of Engineering at SEGRITY where he is responsible for developing the next generation of hydro turbine governors that meet modern performance requirements.

James has also worked for major hydro-focused companies like General Electric and Woodward Governor Company.

Troy Bottomfield, P.E., PMP – Senior Mechanical Systems Engineer at SEGRITY LLC

Troy has over 30 years of experience designing and commissioning high performance hydraulic systems on steam, gas, and hydro turbines. He works at SEGRITY as a Senior Mechanical Systems Engineer where he creates modern designs for turbine governors.

Troy has also worked for General Electric, Woodward Governor Company and Siemens.