

TPM IN AMERICA - PROGRAM 3

PREVENTIVE & PREDICTIVE MAINTENANCE
IN THE TPM ENVIRONMENT

SCENE 1.
FBI WARNING

SCENE 2.
STANDARD SME ANIMATION

- FTB -

SCENE 3.
05:15:35 - 05:15:45

VAUGHN (ON-CAM) :

Get your maintenance practices in good shape, get your preventive maintenance programs operating, and then expand it to include the operators in the TPM program.

- FTB -

SCENE 4.
05:19:18 - 05:19:28

VAUGHN (ON-CAM) :

Because they are the people who are out there every day. They're your eyes and ears of the maintenance department, and they are, I think critically important to be an active part of the program.

- FTB -

SCENE 5.
Interaction between operators & maintenance, TPM activities, OEE chart, etc. (Shots TBD)
TITLE: TOTAL PRODUCTIVE MAINTENANCE - THE SERIES
PART III - PREVENTIVE & PREDICTIVE TOOLS & TECHNIQUES

- MUSIC -

SCENE 6.

NARRATOR (VO) :

WHEN IMPLEMENTING THE TPM PHILOSOPHY ON THE SHOP FLOOR GOOD MAINTENANCE PRACTICES AND A THOROUGH PREVENTIVE MAINTENANCE PROGRAM ARE ESSENTIAL.

SCENE 7.

NARRATOR (VO) :

THIS TAPE SHOWS HOW OPERATOR INVOLVEMENT IN PREVENTIVE MAINTENANCE HELPS REDUCE UNPLANNED DOWNTIME AND ENABLES THE MAINTENANCE DEPARTMENT TO INCREASE MACHINE EFFICIENCY THROUGH MORE ADVANCED PREDICTIVE MAINTENANCE TECHNOLOGIES.

SCENE 8.

NARRATOR (VO) :

HARLEY-DAVIDSON'S PREVENTIVE AND PREDICTIVE MAINTENANCE PROGRAMS AT THE WAUWATOSA, WISCONSIN ENGINE PLANT PROVIDES THE MODEL FOR THIS TAPE. IN THEIR TPM ENVIRONMENT OPERATORS CLEAN AND INSPECT THEIR EQUIPMENT, AS WELL AS PERFORM OILING AND LUBRICATION PREVENTIVE MAINTENANCE DUTIES, OR PM'S.

SCENE 9.

05:03:35 - 05:03:45

VAUGHN (ON-CAM) :

Those are supplemented with certain maintenance oiling activities which are generated in the form of work orders and are done by the maintenance department.

SCENE 10.

NARRATOR (VO) :

OTHER MAINTENANCE DEPARTMENT RESPONSIBILITIES INCLUDE COOLANT RECYCLING, HYDRAULIC OIL FILTERING, MECHANICAL, AND ELECTRICAL PMS. THEY SUPPLEMENT THIS EFFORT WITH THE PREDICTIVE MAINTENANCE TOOLS OF VIBRATION ANALYSIS, OIL ANALYSIS, COOLANT ANALYSIS, AND THERMOGRAPHY. UNDERLYING THIS SYSTEM IS A SOLID PARTNERSHIP BETWEEN PRODUCTION AND MAINTENANCE THAT

SUPPORTS HARLEY-DAVIDSON'S DRIVE TOWARD TPM.

- FTB -

SCENE 11.

CG PAGE: PREVENTIVE MAINTENANCE

SCENE 12.

NARRATOR (VO) :

PREVENTIVE MAINTENANCE IS A SYSTEM OF PREVENTION
ACTIVITIES THAT MAINTAINS A MACHINE'S PROPER
OPERATING CONDITION THROUGH LUBRICATION, INSPECTION,
MACHINE OVERHAUL, AND PART REPLACEMENT.

SCENE 13.

NARRATOR (VO) :

OPERATOR-BASED ROUTINES, CLEANING AND INSPECTING, AND
LUBRICATION PMS FORM THE FIRST-LINE DEFENSE AGAINST
EQUIPMENT FAILURE -- THOUGH OPERATORS GENERALLY
PERFORM NO MORE THAN TWENTY PERCENT OF ALL PMS.

SCENE 14.

NARRATOR (VO) :

CRITERIA COMMONLY USED TO DETERMINE THE LEVEL OF
OPERATOR INVOLVEMENT IN MAINTENANCE ACTIVITIES STATE
THAT TASKS CANNOT TAKE LONGER THAN SIXTY SECONDS TO
COMPLETE, TOOLS OR LADDERS CANNOT BE USED, AND THE
MACHINE CANNOT BE SHUT DOWN.

SCENE 15.

NARRATOR (VO) :

DAILY START-UP AND SHUTDOWN INSPECTIONS AND
ADJUSTMENTS -- USUALLY DOCUMENTED ON CHECKLISTS --
ARE EXAMPLES OF ROUTINES.

SCENE 16.

NARRATOR (VO) :

CLEANING AND INSPECTING IS A PRACTICAL TASK IN WHICH OPERATORS REMOVE WEAR-CAUSING DIRT AND GRIT FROM MACHINED SURFACES, UNCOVER POTENTIAL PROBLEMS, AND ALERT MAINTENANCE BEFORE PRODUCTION IS LOST.

SCENE 17.

05:02:27 - 05:02:33

VAUGHN (ON-CAM) :

Cleaning is primarily done by the operators at the end of the shift, and they have instructions for what to clean on their machines.

SCENE 18.

05:05:07 - 05:05:18

VAUGHN (ON-CAM) :

As we go through our TPM program they get trained on listening and looking and being more conscious of what is going on with their machines so that they can report anything that they see which is unusual.

- FTB -

SCENE 19.

CG: OPERATOR LUBRICATION

SCENE 20.

NARRATOR (VO) :

OPERATOR LUBRICATION RESPONSIBILITIES INCLUDE MONITORING AND MAINTAINING RESERVOIRS AT THE PROPER LEVELS, CHANGING LUBRICANTS, AND GREASING.

SCENE 21.

05:05:51 - 05:06:03

VAUGHN (ON-CAM) :

The number one thing is that you have to have instructions out to the operator so that they know clearly what activities are required, and when they're required, and you have to have the tools available to the operators.

SCENE 22.

05:17:44 - 05:18:00

VAUGHN (ON-CAM) :

We also have operator oiling cards on each of the machines that are exchanged each month that give the

detail for the operator and have the location for the operator to check off when they have done the oiling activities.

SCENE 23.
05:17:33 - 05:17:44

VAUGHN (ON-CAM) :

The primary visual control cards out on the machines are the machine diagrams that indicate where the lubrication activities are and how often they should be done.

SCENE 24.

NARRATOR (VO) :

THESE INSTRUCTION SHEETS, OR PICTORIALS, ARE ATTACHED TO THE MACHINE TO IDENTIFY KEY FOCAL POINTS, AND LIST OPERATOR ROUTINES AND LUBRICATION TASKS. SINCE TPM'S ULTIMATE GOAL IS TO IMPROVE OVERALL EQUIPMENT EFFICIENCY, ZERO OMISSIONS AND ZERO ERRORS IS A CRITICAL STANDARD IN THE PICTORIAL'S DEVELOPMENT. TO ENSURE OPTIMUM EQUIPMENT PERFORMANCE EVERY LUBE POINT, EVERY LUBE TYPE, AND EVERY LUBE TASK MUST BE IDENTIFIED.

SCENE 25.
08:21:39 - 08:21:46

STANEK (ON-CAM) :

You organize it in a way so a person, when he is standing there, the pictorial doesn't reflect all the background noise.

SCENE 26.
08:22:14 - 08:22:33

STANEK (ON-CAM) :

When you analyze, you are actually analyzing the machines from the different power sources moving through the machines, transducing energy from mechanical to electric to hydraulic to pneumatic back to mechanical, and the result is you have a part in your hand, and that organizes your thinking when you are looking at those pictorials.

SCENE 27.

NARRATOR (VO) :

PICTORIALS CLEARLY DEFINE THE ROUTE SEQUENCE AND IDENTIFY DAILY OPERATOR DUTIES THROUGH A SIMPLE COLOR-CODING SYSTEM.

SCENE 28.
08:22:38 - 08:22:45

STANEK (ON-CAM) :
The task orders are written up to prevent you from jumping all over the machinery. You are focusing in a specific area on the machine.

SCENE 29.
09:04:21 - 09:04:30

STANEK (ON-CAM) :
The pictorial has a colored balloon, a little colored circle and that color circle in red indicates that that's an operator responsibility.

SCENE 30.
05:18:01 - 05:18:18

VAUGHN (ON-CAM) :
In addition to that we do put small plastic tags at each of the reservoir locations so that it is quick and easy for the operator to see where to oil, and those tags have the HD number for the oil that is required.

SCENE 31.
08:24:33 - 08:24:47

STANEK (ON-CAM) :
One of the things that doesn't work on a pictorial is putting all the information on the pictorial. The general thing that we put on a pictorial is the daily upkeep tasks only. We don't put all the PM system on the pictorial, there is just too much involved.

SCENE 32.

NARRATOR (VO) :
PICTORIALS FURNISH ACCESSIBLE, PRACTICAL INFORMATION AND ARE USEFUL TOOLS THAT HELP SUSTAIN OPERATOR-BASED LUBRICATION.

SCENE 33.

NARRATOR (VO) :
OILING AND LUBRICATION STATIONS ARE ALSO IMPORTANT IN MAINTAINING OPERATOR INVOLVEMENT. WITH THE HELP OF

L-A-I MAINTENANCE SYSTEMS, HARLEY-DAVIDSON DEVELOPED A SIMPLE, YET VERY EFFECTIVE OILING AND LUBRICATION SUPPORT SYSTEM IN WHICH OPERATORS MAINTAIN MACHINE LUBRICATION LEVELS AND TRADESMEN MAINTAIN LUBRICATION STATIONS.

SCENE 34.
09:02:42 - 09:03:21

STANEK (ON-CAM) :

Part of the criteria is to make sure that the operator has the resources of lubricants and the equipment, such as grease guns and oil cans available to him. If that's not there it's not going to get done. There is no way. If he has to walk further than 30 feet generally it is a hinderance to the maintenance system, or a hinderance to the whole system. So if you take a look at the cells, and you look at the placement of the lubrication support stations, the lube stations, they're stationed throughout the plant in easy access areas and in some cases set up specifically to support a single cell.

SCENE 35.

NARRATOR (VO) :

LUBE STATIONS CAN BE PLACED BY CALCULATING A SIXTY FOOT DIAMETER FROM A SPECIFIC POINT AND IDENTIFYING ALL THE EQUIPMENT WITHIN THAT CIRCLE. THIS DATA CAN THEN BE USED TO DETERMINE ALL THE OIL AND GREASE TYPES NEEDED TO SUPPORT THE AREA.

SCENE 36.
05:07:21 - 05:07:48

VAUGHN (ON-CAM) :

We have HD numbers, they are called HD number one and HD number two and so on. It refers to a particular type of lubricant, and it is an old system, and frankly I don't think there is any rhyme or reason to the numbers except that it allows us to make sure that no matter who is the vendor on the oil that as far as the operator is concerned it is always the same HD number, and it is not confusing to them.

SCENE 37.

TPM2-47 (MS) Pan left lube station
10:20:41 - 10:20:56

NARRATOR (VO) :

THE OIL CONTAINERS ARE COLOR-CODED YELLOW... TAN...
WHITE... ORANGE... BLACK... AND BROWN -- EACH A
GENERIC, PLANT-WIDE CODE THAT CORRESPONDS TO A
PARTICULAR H-D NUMBER.

SCENE 38.
05:09:45 - 05:10:20

VAUGHN (ON-CAM) :

And we have a vendor who monitors our oil level, the
number of barrels we have, and then we take it to a
central oiling station. That is kept full and
maintained by our maintenance department. Then on
third shift, we have millwrights who take oil via an
oil cart to the different oiling stations throughout
the plant, and they keep those oil levels maintained
at the departmental oiling stations. Then the
operators can use that oil within their work area.

- FTB -

SCENE 39.
CG PAGE: MAINTENANCE PMS
SCENE 40.

NARRATOR (VO) :

PMS ARE PRINTED-OUT PROCESS SHEETS THAT IDENTIFY
DAILY, WEEKLY, OR QUARTERLY PREVENTATIVE MAINTENANCE
DUTIES TO BE PERFORMED BY THE MAINTENANCE DEPARTMENT.

SCENE 41.

NARRATOR (VO) :

THESE CAN RANGE FROM SIMPLE, NON-INTERRUPTIVE
LUBRICATION TASKS, TO PART REPLACEMENTS AND MAJOR
OVERHAULS THAT REQUIRE SCHEDULING EQUIPMENT DOWNTIME.

SCENE 42.
05:04:10 - 05:04:24

VAUGHN (ON-CAM) :

Our general mechanical Pms are pretty extensive on

our equipment, and it could involve things like checking backlashes or clearances or torques or belts or other sorts of things on the machines,

SCENE 43.
05:04:25 - 05:04:39

VAUGHN (ON-CAM):
and the electrical PMs are similar in nature in that they check electrical voltage levels and different other things, making sure that the switches work, and that the lights all work on the machines and things like that.

SCENE 44.
05:03:57 - 05:04:08

VAUGHN (ON-CAM):
Any maintenance cleaning that is done is done in conjunction with more general mechanical PM where they would have to remove way covers or things of that nature to get into detail cleaning in inaccessible areas.

SCENE 45.
CG PAGE: PREDICTIVE MAINTENANCE

SCENE 46.

NARRATOR (VO):
PREDICTIVE MAINTENANCE MEASURES PHYSICAL PARAMETERS AGAINST A KNOWN ENGINEERING LIMIT IN ORDER TO DETECT, ANALYZE, AND CORRECT EQUIPMENT PROBLEMS BEFORE PRODUCTION LOSSES OCCUR. IT CAN REVEAL THE CAUSE OF A PROBLEM, AND THEN, THROUGH PLANNED ADJUSTMENTS, HELP PREVENT EQUIPMENT FAILURE AND DETERIORATION.

SCENE 47.
05:10:39 - 05:10:48

VAUGHN (ON-CAM):
Well today, primarily we use some oil sampling, a little bit of infrared scanning, but our major one is vibration analysis.

SCENE 48.
06:02:30 - 06:02:43

SCHERBERT (ON-CAM):
Our main predictive maintenance focus is in vibration analysis. Where we currently are taking samples on approximately 30% of our machines.

SCENE 49.

NARRATOR (VO) :

VIBRATION ANALYSIS COLLECTS DATA ON MECHANICAL COMPONENTS THAT'S DOWNLOADED TO A COMPUTER AND THEN USED TO DIAGNOSE EQUIPMENT PERFORMANCE.

SCENE 50.

06:02:47 - 06:03:14

SCHERBERT (ON-CAM) :

That involves taking samples on bearings, spindles, gear boxes, pumps, cooling pumps, hydraulic pumps, and taking that data, installing it, downloading it into a computer, PC, and looking over the trends and looking for changes in our operation of the machinery.

SCENE 51.

05:11:52 - 05:12:08

VAUGHN (ON-CAM) :

We can find a number of problems. The most common ones are probably bearing problems. Once in a while we will find a gear related problem in the equipment and occasionally there will be some out of balance sorts of problems too.

SCENE 52.

05:11:34 - 05:11:44

VAUGHN (ON-CAM) :

We generate reports each month on machines and show trend lines. Then if there are problems out there we go ahead and schedule that machine to be repaired.

SCENE 53.

NARRATOR (VO) :

AN INCREASE IN AMPLITUDE INDICATES A PROBLEM AND HELPS PREDICT WHEN A COMPONENT MAY FAIL.

SCENE 54.

06:06:10 - 06:06:34

SCHERBERT (ON-CAM) :

As we see increases in amplitude, which tells us how much that particular component is vibrating, that normally tells us what condition that particular component is in. The frequencies are very important because that tells us what is generating that frequency.

SCENE 55.

06:04:14 - 06:04:21

SCHERBERT (ON-CAM) :

Whether it be gear frequency, bearing frequency, or a pump frequency being passed.

SCENE 56.

05:14:14 - 05:14:24

VAUGHN (ON-CAM) :

There have been a lot of machines that we have gone in, gotten the parts for, scheduled them, repaired them, and had no interruptions to production.

SCENE 57.

05:13:18 - 05:13:47

VAUGHN (ON-CAM) :

I remember, one time in our heat treat department where we had measured some coolant pumps, and initially the person back in the area didn't think there was anything wrong with the coolant pumps even though the vibration analysis indicated that there was a problem, and when it failed about a week later, the next time we told him there was a problem with the pumps, he got it fixed immediately. We certainly have made some believers and eliminated a lot of down time.

SCENE 58.

06:04:21 - 06:04:24

SCHERBERT (ON-CAM) :

It is a very helpful tool in the predictive end of our maintenance.

SCENE 59.

NARRATOR (VO) :

OIL ANALYSIS -- ANOTHER IMPORTANT TOOL IN PREDICTIVE MAINTENANCE -- SAMPLES OIL FROM MECHANICAL DRIVES AND EXAMINES IT FOR METAL WEAR PARTICLES.

SCENE 60.

05:10:50 - 05:11:07

VAUGHN (ON-CAM) :

In the oil sampling, we'll take samples and send them out to a lab for analysis, and then either change the oil or filter the oil depending on the results. It does help us in some cases identify that there might be a problem with a bearing starting to fail and that sort of thing.

SCENE 61.

06:04:39 - 06:05:12

NARRATOR (VO) :

METAL PARTICLES FOUND IN OIL SAMPLES MAY INDICATE

DETERIORATING VALVES, SPINDLES, GEARS, OR BEARINGS.
IF PARTICULATE COUNT INDICATES A COMPONENT IS
WEARING, VIBRATION ANALYSIS COULD THEN BE USED TO
PINPOINT THE POTENTIAL PROBLEM.

SCENE 62.

NARRATOR (VO) :

HARLEY ALSO EMPLOYS COOLANT SAMPLING AND INFRARED
SCANNING PREDICTIVE MAINTENANCE TECHNIQUES, ALTHOUGH
THESE TESTS ARE CONDUCTED BY OUTSIDE SERVICE FIRMS.

SCENE 63.

05:11:09 - 05:11:19

VAUGHN (ON-CAM) :

With the scanning, today primarily that is done
through a subcontractor and we are primarily looking
at power distribution which is something we are going
to expand in the future I believe.

SCENE 64.

06:02:13 - 06:02:28

SCHERBERT (ON-CAM) :

Thermography, we are normally just checking our buss
ducts for any heat, or looking for any type of heat
rises and differentiations.

SCENE 65.

06:01:54 - 06:02:09

SCHERBERT (ON-CAM) :

Our coolant sampling is done fairly regularly to look
for contaminants in our coolant; oil or any other
particles that would cause our operation not to
function right.

- FTB -

SCENE 66.

NARRATOR (VO) :

TPM IS A POWERFUL METHOD FOR IMPROVING MACHINE
RELIABILITY -- AND PREVENTIVE MAINTENANCE IS AN
ESSENTIAL COMPONENT OF ANY SUCCESSFUL TPM PROGRAM.

SCENE 67.

06:14:26 - 06:14:45

SCHERBERT (ON-CAM) :

Through the implementation of PMs here at Harley-Davidson we've been able on the lube reservoirs, through cleaning and changing of filters, I've seen a great decrease in down time because of the fact that all the lube points are being supplied with oil.

SCENE 68.

05:09:04 - 05:09:23

VAUGHN (ON-CAM) :

We rarely have a lubrication related problem today, and we used to have five or six a week. We would go out there and find out that there was a major problem, where ball screws were torn out, or gear boxes were all screwed up, but that rarely happens now.

SCENE 69.

NARRATOR (VO) :

AS HARLEY HAS DISCOVERED, ALLOWING OPERATORS TO PERFORM AUTONOMOUS PREVENTIVE MAINTENANCE TASKS CAN BRING MANY BENEFITS AND IMPROVEMENTS NOT ONLY TO THE COMPANY, BUT TO ITS EMPLOYEES AS WELL.

SCENE 70.

06:11:02 - 06:11:32

SCHERBERT (ON-CAM) :

With the programs that are implemented here at Harley we've been able to free up some of our tradespeople to do more of our predictive end, which makes the job a lot more interesting, versus going out and doing the reactive down machine type work, day in and day out, which becomes repetitive at times. It helps us to look into the future and do more predictive. It makes the job a lot more interesting.

SCENE 71.

06:09:16 - 06:09:51

SCHERBERT (ON-CAM) :

We've relocated oiling points to help in the oiling operation here at Harley Davidson. What we'll do is move a component such as an air line oil, air lubricator, to a convenient location for the operator to maintain and fill, and it visually enhances the machine also. It makes everything look cleaner, and the operator is able to access those areas a lot easier.

SCENE 72.

06:10:11 - 06:10:22

SCHERBERT (ON-CAM) :

We've also cleaned up a lot of areas by stacking transformers on top of a hydraulic unit, just to clean the area up.

SCENE 73.

NARRATOR (VO) :

AT HARLEY-DAVIDSON PREVENTIVE AND PREDICATIVE MAINTENANCE TECHNIQUES ARE WORKING TOGETHER WITHIN THEIR TPM PROGRAM TO REDUCE REPAIR COSTS, INCREASE PROFITABILITY, AND BRING OVERALL EQUIPMENT EFFECTIVENESS TO WORLD-CLASS STANDARDS.

SCENE 74.

05:23:47 - 05:24:29

VAUGHN (ON-CAM) :

When we first looked at the program, we did an analysis of how much additional capacity we could get out if we improved our overall equipment effectiveness rating from where we had estimated it was up toward the 85% goal that most people set. That met all of our corporate investment objectives which is basically 35% return on investment. In fact it exceeded the 35% that we set as a company. I believe that right now we are seeing those kinds of results in the additional capacity within our plant.

SCENE 75.

06:13:01 - 06:13:12

SCHERBERT (ON-CAM) :

Harley is always trying to attain more engine output, and they are doing that, I believe through better maintenance, less down time.

- FTB -

SCENE 76.

NARRATOR (VO) :

PLEASE REFER TO YOUR WORKBOOK FOR MORE INFORMATION ON PREVENTIVE AND PREDICTIVE MAINTENANCE. NEXT, PROGRAM FOUR -- THE COMPUTERIZED MAINTENANCE MANAGEMENT

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SYSTEM -- WILL SHOW HOW THE COMPUTER CAN IMPROVE ALL
ELEMENTS OF THE MAINTENANCE ORGANIZATION AND
CONTRIBUTE TO PRODUCTIVITY.