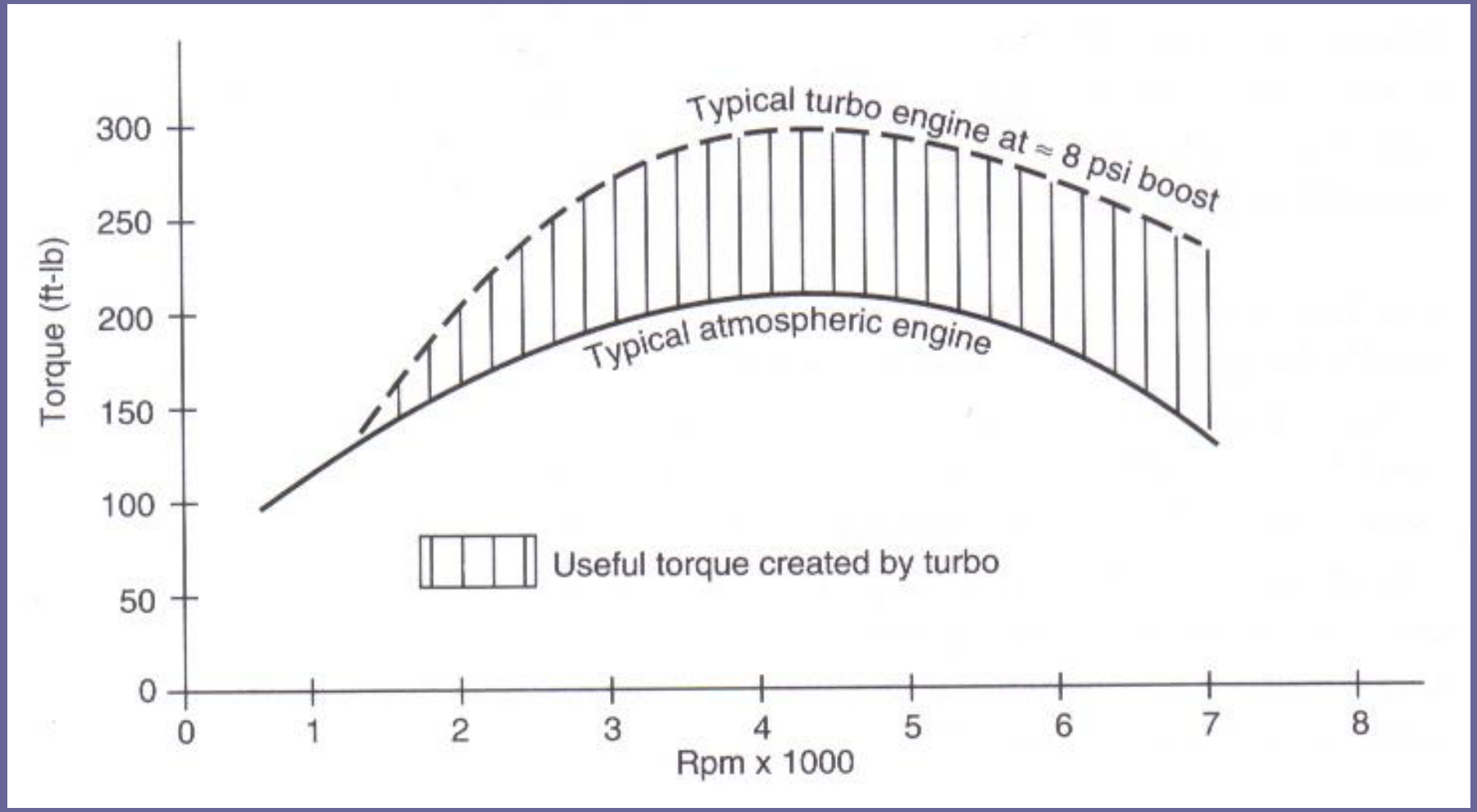
TURBOCHARGING

WHAT IS IT?

1. GAINS IN TORQUE
2. AIR COMPRESSOR DRIVEN BY EXHAUST GASES


Typical turbo engine at ≈ 8 psi boost
Typical atmospheric engine
Useful torque created by turbo
Torque (ft-lb)
300
250
200
150
100
50
0
0
1
2
3
4
5
6
7
8
Rpm x 1000

MECHANICALCONSTRUCTION

- TURBINE AND COMPRESSOR HOUSINGS
- CENTER CARTRIDGE
- WASTEGATE

TURBINE HOUSING

- BOLTS ONTO EXHAUST MANIFOLD
- TURBINE WHEEL IS DRIVEN BY EXHAUST GAS

COMPRESSOR HOUSING

- INTAKE SYSTEM FLOWS THROUGH
  COMPRESSOR HOUSING
- COMPRESSOR WHEEL CONNECTED
  BY A SHAFT TO TURBINE WHEEL
- COMPRESSOR WHEEL COMPRESSES

CENTER HOUSING ROTATING ASSEMBLY

- CONTAINS TWO BRONZE THRUST BEARINGS
- HOLES FOR LUBE OIL
- HOLDS THE WHEEL/SHAFT IN PLACE



TURBINE HOUSING

- Exhaust inlet – attaches to manifold
- Exhaust outlet – bolts to O2 housing/ exhaust system
- Exhaust pulses drive the turbine wheel of 150,000 RPM +
- Gases flow through the exhaust manifold, turbine housing and out the exhaust outlet into the exhaust pipe



TURBINE HOUSING

- GASES BYPASS THROUGH THE WASTEGATE TO LIMIT BOOST
- TURBINE WHEEL RESTRICTS EXHAUST FLOW
- TEMPERATURES RISE TO 1600°F IN THE MANIFOLD



COMPRESSOR HOUSING

IMPELLER WHEEL

- ON SAME SHAFT AS TURBINE WHEEL
- THEY SPIN AT THE SAME SPEED
- SUCKS AIR IN THE COMPRESSOR INLET
- COMPRESSED AIR FORCED OUT OUTLET





CHRA

- OIL COOLED OR OIL/WATER COOLED
- GENERALLY TWO THRUST BEARINGS
- OIL FEED AND RETURN LINE TO THE OIL PAN
- MOST COME WITH OIL/WATER COOLING FOR LONGEVITY
- AT SUCH HIGH TEMPERATURES, SHUTTING OFF THE ENGINE RIGHT AWAY COKES THE LINES AND TURBO
- IDLE THE ENGINE FOR 30-120 SEC BEFORE SHUT DOWN



INTERNAL WASTEGATE AND ACTUATOR

- PUSH/PULL TYPE SOLENOID PRESSURE SETTING
- CONNECTS VIA PUSHROD TO OPEN AND CLOSE THE WASTEGATE FLAPPER VALVE
- WASTEGATE IN THE TURBINE HOUSING OPENS SLIGHTLY BEFORE SET BOOST PRESSURE AND BYPASSES AIR TURBINE WHEEL INTO EXHAUST

- STOPS THE BOOST PRESSURE FROM RISING
- EXTERNAL WASTEGATE
- MOUNTS ON EXHAUST MANIFOLD RUNNER OR O2 HOUSING
- BYPASSES AIR AROUND WHOLE TURBO TO ATMOSPHERE OR EXHAUST



COMPRESSOR BYPASS VALVE "BLOW-OFF VALVE"

THE TURBO IS BEFORE THROTTLE PLATE

- AT WOT COMPRESSED, AIR EXITS COMPRESSOR HOUSING THROUGH THROTTLE BODY INTO INTAKE MANIFOLD
- THE THROTTLE PLATE CLOSES ON SHIFTS
- AT THIS POINT, THE INTAKE IS PRESSURIZED BY THE TURBO UP TO THE CLOSED THROTTLE PLATE
- THE AIR EXPANDS AND DECOMPRESSES, BUT, WITH A CLOSED THROTTLE PLATE, IT EXPANDS BACK INTO THE COMPRESSOR HOUSING

- PRESSURE BACKING UP INTO THE WHEEL CAUSES COMPRESSOR SURGE
- COMPRESSOR SURGE IS WHEN WHEEL SPEED FLUCTUATES RAPIDLY
- THIS BENDS THE FINS OF THE IMPELLER
- TO PREVENT THIS, THE AIR BYPASS VALVE BLEEDS OFF PRESSURIZED AIR INTO THE INTAKE BEFORE THE TURBO OR INTO THE ATMOSPHERE



RECIRCULATED

VENTED TO ATMOSPHERE



INTERCOOLING

- Hot air enters the combustion chamber and raises combustion temperatures
- Each turbo is given an efficiency rating STATING it's ability to compress air without raising the temperature BEYOND LIMITS FOR thermodynamics states
- THE Higher the percentage, THE cooler the air
- To lower air temperature and increase density, an intercooler is placed between the turbo and the intake manifold

THE INTERCOOLER

- “AIR-AIR RADIATOR”
- RATED BY PRESSURE DROP AND EFFICIENCY
- THE BIGGER THE CORE, THE BIGGER THE DROP
- COMPARE TEMP RISE FROM TURBO TO THE AMOUNT OF HEAT REMOVED

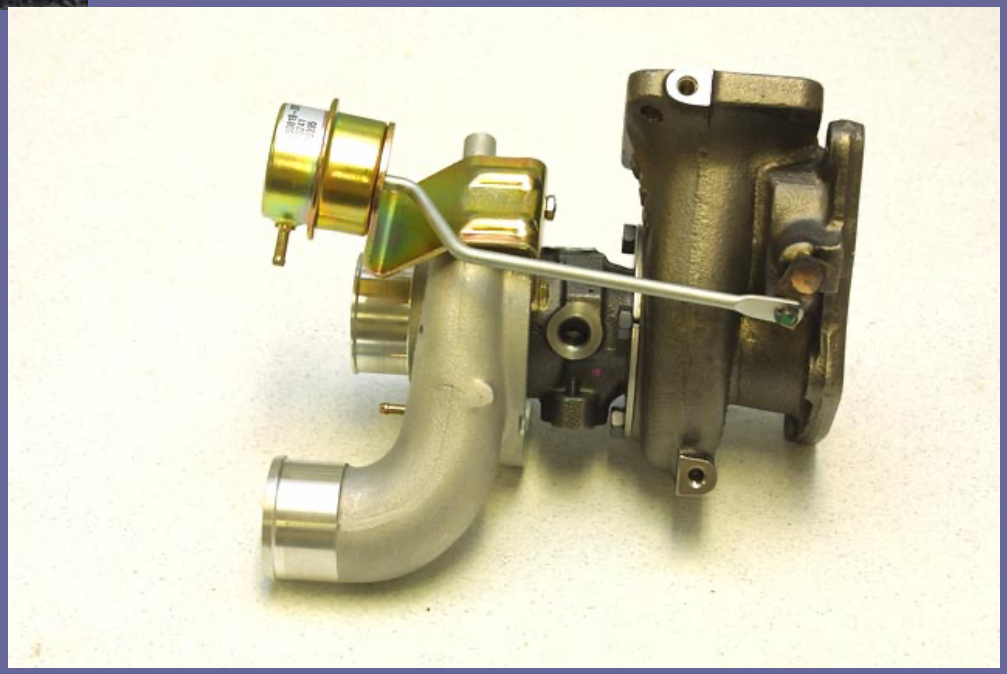


BOOST CONTROL

- WASTEGATE IS SET TO OPEN AT CERTAIN PRESSURE
- A VACUUM/BOOST LINE RUNS FROM BOOST SOURCE (COMPRESSOR HOUSING NIPPLE OR INTERCOOLER NIPPLE) TO WASTEGATE ACTUATOR
- WITH BOOST LINE OFF OF THE WASTEGATE ACTUATOR, THE WASTEGATE WILL NOT OPEN
- A MANUAL BOOST CONTROLLER IS AN AIR BLEEDER VALVE
- IF YOU BLEED OFF 5 PSI, THE ACTUATOR SEES 5 PSI LESS THAT THE TURBO IS ACTUALLY PRODUCING, THUS ENABLING YOU TO RUN 5 PSI MORE THAN THE ACTUATOR RATING
- AN ELECTRONIC BOOST CONTROLLER HAS A MOTOR THAT VARIES THE AMOUNT OF BOOST THE WASTEGATE SEES



INTERNAL WASTEGATE ACTUATORS



ABNORMAL BOOST CONDITIONS

BOOST CREEP

- THE MORE AIR COMPRESSD, THE MORE AIR FLOWS THROUGH THE EXHAUST AND THE TURBINE WHEEL
- THE WASTEGATE IS A SET DIAMETER WHICH HAS A MAXIMUM AMOUNT OF AIR THAT CAN FLOW THROUGH IT AT A CERTAIN DENSITY AND VELOCITY
- THE BOOST PRESSURE CREATED IS DIRECTLY PROPORTIONAL TO THE SPEED OF THE TURBINE WHEEL

- IF THE AMOUNT OF AIR BYPASSING THE TURBINE WHEEL EXCEEDS THE AMOUNT OF AIR THAT THE WASTEGATE CAN FLOW, IT GETS FORCED THROUGH THE TURBINE WHEEL INSTEAD.
- THIS INCREASES WHEEL SPEED AND BOOST PRESSURE COMPOUNDING THE PROBLEM.
- BOOST CREEP WILL GET TO THE DESIRED BOOST LEVEL, THEN PAUSE MOMENTARILY, THEN IT WILL START RISING AGAIN (12 PSI @ 3600 RPM TO 28 PSI @ 7200 RPM)

REMEDIES

- BIGGER FLAPPER DOOR
- PORT THE WASTEGATE PASSAGES

BOOST SPIKE

- WILL JUMP UP PAST THE DESIRED BOOST THEN DROP BACK DOWN TO SET POINT
- THE WASTEGATE IS NOT OPENING FAST ENOUGH TO EXPEL ENOUGH AIR TO STOP BOOST RISIE
- ONCE THE WASTEGATE OPENS TO BYPASS ENOUGH AIR, THE BOOST WILL DROP TO DESIRED LEVEL

CHOOSING A TURBO

COMPRESSOR MAPS

- P2/P1 = BAR
- P2 = BOOST PRESSURE + ATMOSPHERIC PRESSURE
- P2 = ABSOLUTE PRESSURE
- P1 = ATMOSPHERIC PRESSURE = 14.7 PSI
- EXAMPLE :
    - 17 PSI (BOOST) + 14.7 PSI / 14.7 PSI
    - 2.15 BAR (1 BAR = 14.7 PSI)

- MATCH DESIRED BOOST PRESSURE WITH SYSTEM AIRFLOW
- THIS WILL GIVE YOU COMPRESSOR EFFICIENCY
- DO NOT RUN OVER THE SURGE LIMIT OR YOU WILL DESTROY YOUR COMPRESSOR WHEEL

ENGINE PREPARATION

- OEM NATURALLY “ASPIRED” ENGINES OK UP 5 PSI TURBO BOOST
- DON’T RUN BOOST OUTSIDE OF THE TURBO EFFICIENCY RANGE
- CONSIDER COMPRESSION RATIO, BOOST PRESSURE, FUEL OCTANE, AND INTERCOOLER AND COMPRESSOR EFFICIENCY

CYLINDER HEAD PREP

- COMBUSTION TEMPERATURES AND PRESSURES ARE MUCH HIGHER THAN IN A NA ENGINE
- THEREFORE ANY RESTRICTIONS IN THE AIRFLOW, OR SHARP EDGES IN THE CHAMBERS EXPONENTIALLY DECREASE THE AIRFLOW AND INCREASE THE CHANCE OF DETONATION
- HEAD GASKET SEALING IS CRITICAL
- INCREASED STRENGTH VALVE SPRINGS MIGHT BE NEEDED AS THE PRESSURE ON THE BACK OF THE VALVES REDUCE EFFECTIVE SPRING PRESSURES

BLOCK PREP

- DEPENDING ON CYLINDER WALL RIGIDITY, SLEEVES MAY BE REQUIRED
- DECK STRAIGHTNESS IS CRITICAL (HEAD GASKET SEALING)
- WEAKER DECKS MIGHT NEED O-RINGS FOR EXTREME HIGH BOOST PRESSURES (RACING)
- STRONG MAIN STUDS AND/OR A MAIN GIRDLE ARE RECOMMENDED
- PROPER PISTONS TO ADJUST COMPRESSION RATIO
- GOOD RODS THAT CAN TAKE THE ADDED STRESS

CLAMPING AND SEALING

- HIGH STRENGTH HEAD STUDS RECOMMENDED
- MLS GASKETS LIKELY BEST CHOICE
- HIGH QUALITY FIRE-RINGS ARE NECESSARY ON THE GASKET

PISTON DESIGNS

- FORGED, CAST HYPEREUTECTIC AND T6 HEAT-TREATED HYPEREUTECTIC ALLOY
- RING LANDS MUST BE THICK, ON AVERAGE TWICE AS THICK AS ON NA ENGINES
- HELPS WITH ADDED INERTIAL LOADS AND COMBUSTION PRESSURE AND DEFENDS AGAINST DETONATION
- HEAT BARRIERS AND HEAT REMOVAL; CERAMIC COATINGS ON PISTON TOPS AND OIL SPRAY ON THE UNDERSIDE